

The background of the entire page is a repeating pattern of circular emblems and stars. Each emblem contains a stylized representation of a building or architectural structure, surrounded by a wreath. The stars are five-pointed and scattered throughout the pattern.

THE UNIVERSITY
OF ILLINOIS
LIBRARY

630.8
On 81ab
no.135-50





Digitized by the Internet Archive
in 2014

<https://archive.org/details/bulletin1351onta>

Ontario Agricultural College and Experimental Farm

THE CREAM-GATHERING CREAMERY.

By H. H. Dean, B.S.A., Professor of Dairy Husbandry, and J. A. McFeeters,
Instructor in Dairy School, O.A.C.

The manufacture of butter on the farms of Ontario is carried on in many cases under discouraging circumstances. Labor is becoming more difficult to secure each year, and especially the kind of labor required to make good butter. Not only is the labor problem a serious one, but the fact that many farms lack suitable utensils and a suitable place in which to set the milk and make butter, causes a very inferior quality to be produced. Then, again, this butter is often "traded out" for dry goods and groceries, where no discrimination in price is made between good and bad butter. This system does not encourage the good buttermaker, but places a premium on carelessness and inferior butter. In a discriminating market the difference in price between inferior dairy butter and the best creamery butter is from five to ten cents per pound. The difference is sufficient to pay the cost of manufacturing at the creamery, and leave a good margin of profit to the farmer. Besides this, the work on the farm is lessened very much by having the butter made in a creamery. If the persons producing "ten-cent butter" were able to produce it so cheaply that they make a profit at this price, the situation would not be so bad. However, when we consider that the average food-cost of one pound of butter is probably about ten cents, the profit on such butter is very small, if, indeed, it is not produced at a loss. Not only does the farmer lose money through inferior dairy butter, but the merchant, the dealer, and the reputation of Canadian butter, all sustain a loss. The remedy for this in the majority of cases, is the adoption of the creamery or co-operative plan of buttermaking.

CREAM-GATHERING AND WHOLE MILK CREAMERIES.

Many districts, owing to the small cow population scattered over a considerable extent of territory, are unsuitable for delivering the whole milk at the creamery. The cost of hauling the milk from the farm to the creamery and the skim-milk back to the farm is altogether too great, hence the plan of creaming the milk on the farm, by setting it in cans or pans, or by means of a cream separator, and sending only the cream to the creamery, is being more generally adopted. While the average quality of the butter is not so good under this system, the advantages outweigh the disadvantages in many cases. The cream-gathering creamery is a great improvement over the plan of making butter under the conditions which prevail on the average farm. There are farm dairies which turn out a quality of butter equal to the best creamery, but they are the exception rather than the rule.

THE COWS.

The dairyman satisfied with anything short of the best cows obtainable may not be considered progressive. If the best native or grade cows

are used for foundation stock, the herd may be very much improved by raising the heifer calves from these cows, if sired by pure-bred males belonging to one of the dairy breeds. These heifers should be reared on new milk for about three weeks, then be gradually changed to warm, sweet skim-milk. In addition, they should be fed some ground oats and bran mixed in equal parts, green feed in summer, and clover hay and roots in winter. They should be kept in a thrifty, growing condition, but not too fat. They should freshen when about two and one-half years old, and again twelve to fifteen months later. At the end of the second lactation period all heifers which do not give at least 6,000 pounds of milk, or make 250 pounds of butter, should be disposed of, unless in special cases, when a third trial may seem to be advisable.

To find the individual production of the cows, it is necessary to weigh the milk from each cow at stated intervals throughout the year, and also to take samples for testing with the Babcock test, in order to determine the fat in the milk. The pounds of milk given in any period of time multiplied by the percentage of fat in the milk, plus one-sixth, is approximately the butter produced.

For example, if a cow produced 30 pounds of milk daily on three consecutive days in the month of April, the pounds of milk produced for the month would be about 900. If this tested 3.5 per cent. fat., the pounds of milk fat would be 900×3.5 , divided by 100 equals 31.5 pounds fat; 31.5 plus 1-6 equals 36.75 pounds of butter for the month. The sums of the individual monthly milk and butter production would be the approximate amount of milk and butter produced by each cow during the year.

FEEDING THE COWS.

Where cows have plenty of good grass and are in good condition, no other feed is necessary. Where the pastures are short they should receive green peas and oats, green clover, corn or mangels, or, what is preferable, considering the cost and convenience, a small silo should be filled with good corn for summer feeding. This silo should not have more than three or four square feet of surface for each cow to be fed. About twenty pounds of corn silage and two to four pounds of bran or chopped oats will maintain the milk flow during a period of short pasture.

For winter feeding, a daily ration of corn silage (35 pounds), clover hay (8 to 10 pounds), mangels (20 to 30 pounds), bran (4 pounds), oats (3 pounds), and oil cake (1 to 2 pounds), will produce a satisfactory and economical flow of milk with good cows. If possible, the hay should be cut, the mangels pulped, and both mixed with the corn silage from six to twelve hours before feeding. The meal should be fed according to the milk flow, using about 8 pounds of the mixture for each 30 pounds (3 gallons) of milk produced, or for each pound of butter in the milk. The careful feeder will soon learn the capacity of each cow for economical milk and butter production.

All cows should be treated kindly. This is especially necessary with the young cow. Vicious cows are usually the result of bad handling and harsh treatment. Cows should also be kept in clean stables, which are well ventilated, light, convenient and sanitary. While in the fields, and where possible in the stables, they should have access to plenty of pure water and clean salt.

The cows when inside should be kept clean. This can be done by having the stalls of proper length with a drop behind the cows, and by using the currycomb and brush frequently on the cows. If the hair on the hind-quarters and tail is clipped in the fall, it is much easier to prevent dirt sticking to them.

Milking should be done regularly, with clean, dry hands. The milk pails should be clean and of uniform weight for weighing the milk. Immediately after milking the milk should be strained through a fine wire strainer and two to four thicknesses of cheesecloth. The milk should then be set or separated as soon as possible.

CREAMING THE MILK.

There are three common methods of getting the cream from milk—shallow pans, deep cans and the modern cream centrifuge or separator.

Shallow Pans. Cream from small, shallow pans is frequently not suitable for sending to the creamery in hot weather, because it is usually sour when removed from the milk or shortly after. If the patron has a clean, cool cellar, free from bad flavors, dust and draughts, where the temperature does not go above 60 degrees at any time, the cream from milk set in small pans may be in fairly good condition. Such cream should be removed from the pans about twenty-four or thirty-six hours after setting, and while the milk is still sweet. The cream should be taken off carefully by first separating the cream from the edge of the pan with a thin-bladed knife. Then wet the edge of the pan with some of the milk, when the cream may be carefully run into a cream can, removing as little of the skim-milk as possible. Perforated skimmers should not be used, as they are wasteful of the fat. The pans, after skimming, should be emptied at once, be rinsed with cold water, then washed with hot water, and afterwards scalded and put out in the air and sunshine. Pressed tin pans without seams, or graniteware, should be used.

Deep Setting. The best method of obtaining cream by gravity is by setting the milk in cans which are about eight inches in diameter and twenty inches deep. These cans of milk may be set in a stream or box of running cold water or in ice water. The temperature of the water should be from forty to forty-five degrees F. A very good rule is to have some ice in the tank all the time. The milk should be put into the cans as soon as possible after milking, then set in the cold water, with the covers on the cans. The water should be as high as the milk in the cans, or the cans may be put under the water, if made for that purpose. At the end of twelve or twenty

hours the cream may be taken off by means of a cone-shaped dipper from the top, or the skim-milk may be removed from below the cream through a suitable tap. It is necessary to have a glass in the side of the can near the tap, so that the operator can tell when the skim-milk is all removed. Cans which are skimmed from the bottom should be either cone-shaped or slanting on the bottom, so as to remove any sediment there may be with the first-drawn skim-milk, and also in order to assist in removing all the skim-milk from under the cream. The skim-milk next to the cream line may contain an extra amount of fat, but as a rule it should be drawn quite closely to prevent the cream being too thin.

Some cans are stationary in the creamer box. This plan saves the labor of lifting the cans in and out of the water, but they are more difficult to clean, and more liable to rust and leak when so fixed.

The cans should be treated similarly to the pans when washing them—empty at once, rinse with cold water, then wash with hot water, scald and put outside. Where a double set of cans are available, it will pay to allow the cans to set twenty-four hours, otherwise they must be skimmed and washed twice a day.

The cream should be kept in cold water until it is called for by the driver, which should be daily in hot weather, and not less than three times a week at any time. It is very important that the cream be kept sweet until it is delivered at the creamery. The patrons can assist in this matter by keeping the cream cold. All the cream on hand should be given to the driver. The plan of holding some of the cream back in order to get a higher test is not advisable, as it tends to spoil the quality of the butter, and is of no advantage to the patron, but rather a disadvantage, when the Babcock test is used.

The Cream Separator. For those patrons who have six or more good cows a hand separator is a great help. If some power is available, such as steam, electric or tread, it reduces the labor and expense to have the separator run by power other than hand. However, these machines are now made so that hand power is practicable. There is no best separator. No one machine has all the good points, and no one is free from all defects. There is, also, in many cases, as much difference between machines of the same make as between those from different manufacturers. The best cream separator is the one which can cream the most milk in a given time, leaving not over five-one-hundredths of one per cent. fat in the skim-milk, and giving a cream testing not less than twenty-five per cent. fat, and at the same time can be purchased at a reasonable price, with a guarantee from the manufacturer that it will do the work claimed for it, or the machine is to be removed without cost to the purchaser.

The most convenient place for a separator is in a room connected with the stable. The whole milk is then convenient for separating and the skim-milk for feeding. This room, however, as well as the machine should be kept clean. This involves carrying hot water from the house for cleaning, and frequently this is neglected, and the room and the machine are often found in anything but a cleanly condition.

If extra help or mechanical power are available, the separator may be started soon after milking commences, so that the cream and skim-milk are separated shortly after the milking is done. Where this is not practicable, the separating should take place as soon as possible after milking. The bowl of the separator should be wet and warmed by pouring in a quart or two of hot water before allowing any milk to enter. This prevents the cream sticking to the bowl, and allows of a more complete separation. The speed should be as uniform as possible, at the rate recommended by the manufacturer. A little above this speed, five or six turns to the minute, will do no harm. The supply can should, as far as possible, be maintained nearly full of milk. After all the milk is out of the supply can, a quart of warm water may be added to the bowl to flush out the cream. The bowl should then be allowed to stop of its own accord, then be washed. The slime on the inside of the bowl should be burnt. After washing and scalding, the parts should be exposed to the air in a clean place. The skim-milk tubes and all parts not easily cleaned with a brush should receive special attention at the hands of the person responsible for washing. Sometimes bad flavors and sour cream result from improperly washed machines. It is needless to say that the machine should be thoroughly washed after each time of using. Merely rinsing with cold water and washing once a day or once a week is not sufficient.

Immediately after separating the cream should be set in cold water and stirred until it reaches a temperature of about 50 degrees. Fresh cream should not be added to cream from previous separations until it has been cooled down to below 60 degrees. Warm, fresh cream added to the older cream causes unpleasant fermentations, which give the cream a bad flavor.

RICH CREAM ADVISABLE.

Not more than ten or twelve per cent. of the whole milk should be taken in the form of cream. Where scales are convenient, it would be well for those using the hand separators to weigh the milk and cream occasionally in order to see how much cream is being taken. Where there are no scales, the cream should be measured. From ten gallons of milk not more than one to one and a quarter gallons of cream should be taken. Using too much water or skim-milk to flush out the bowl will cause a thin cream.

The advantages of rich cream are :

1. The patron has more skim-milk for feeding stock.
2. It costs less for hauling the cream to the creamery.
3. Less labor and expense are required in cooling the cream at the farm and factory.
4. Less vat and churning room are needed for a given amount of butter.
5. There is less danger of the cream becoming too sour.
6. There is less loss of fat in the buttermilk by churning rich cream, and the quality of the butter is better because it can be churned at a lower temperature than can poor cream, or cream containing a low percentage of fat. The cream at the farm should not test less than twenty-five per cent. fat from the hand separator.

Wooden stirrers should not be used for stirring cream in the can. These are difficult to keep clean, and often impart a bad flavor to the cream. The stirrer should be made of tin, with few seams, and all crevices should be filled with solder.

The patron's cream can should be rinsed with very little water when it is emptied into the driver's pail, as this dilutes the cream. It is preferable to remove the cream adhering to the sides of the can with some sort of a scraper, but this must be kept clean.

DELIVERY OF CREAM.

The importance of making frequent collections of cream is a matter too often underestimated by creamery managers. The facilities at the command of the average patron for keeping milk or cream in a clean, sweet condition are very limited, and it is very seldom that cream left in the hands of patrons for more than three days will prove to be of fine quality. It is quite safe to say that, other conditions being equal, the more frequent the collections of cream, the better will be the quality of butter produced.

On the other hand, the cost of collecting, which is one of the largest items in the cost of manufacture, has to be considered. The greater the amount of cream obtainable in a given area, the lower will be the cost per pound of butter for collecting.

While seeking to practice economy on one hand, quality of butter should not be lost sight of on the other. It is, or should be, quality which determines the commercial value of dairy products.

A district or route which will not furnish sufficient cream to warrant making at least three collections per week during the summer months will scarcely be profitable.

At times we find some drivers adopting the practice of omitting to call on patrons supplying small amounts of cream, and especially those located at outlying points. The fact should not be lost sight of that the addition of a few small lots of cream that have developed a high acidity or an objectionable flavor, from a pantry or cellar, may materially lower the grade of the butter manufactured from the entire load.

A really choice quality of cream will scarcely be obtained unless there are from four to six collections made each week.

MEANS OF DELIVERY.

Oblong or oval tanks have proved very satisfactory for the use of cream collectors. The sides, top and bottom, should be well insulated, and the edges of the lids inlaid with cork in order to make a close joint. The inner lining should be of heavy tin (22 or 24 gauge), with as few seams as possible. Long, oblong tanks require some support for the sides, and should have two square "wings" or partitions, extending from the top to within one or two inches of the bottom. These "wings" prevent, to some extent, the swaying and splashing of the cream from one end of the tank to the other while en route to the creamery. The oval-shaped tanks, however, do not seem to require any special "splash-wings."

In placing an order for new tanks, such specifications of outlets or "taps" should be given as would best serve the requirements of the particular location of the factory. For instance, if the receiving door or window were accessible from one direction only, then it would be necessary to have the outlet of the tank on the side or end next the creamery. A tap or other outlet placed in one corner of a tank affords the best possible means of draining, as the platform or driveway may be levelled so as to throw one rear waggon wheel lower than the rest, thus causing the tank to drain freely.

As a creamery inch contains about 113 cubic inches, the capacity in inches may be estimated by dividing the number of cubic inches by 113. The capacity in pounds may be obtained by dividing the number of cubic inches by 27.5848—the number of cubic inches in one pound of cream.

Insulated or jacketed cans, holding from 30 to 35 creamery inches, are preferable in some ways to tanks. Where these are used a buttermaker is sometimes able to "grade" the cream when receiving it at the factory. If the contents of one can is found to be overripe or "off" in flavor, a maker may locate the source of trouble with much less difficulty than when tanks are used. On the other hand, however, well constructed tanks give better protection to the cream during transit. At creameries where both tanks and cans are in use, the temperature of the cream received from the tanks during warm weather is frequently six degrees lower than that delivered in cans.

The ideal system of delivery would find its nearest approach in the use of separate cans for each patron. The measuring or weighing and sampling would then justly fall to the buttermaker, who would then be brought in close touch with the cream produced by each patron. This plan also enables the manager, if he wishes to do so, to grade the cream, and pay for it according to whether it is first or second class.

When cream collectors are provided with a means of straining each lot of cream, a patron's attention may be drawn to any curd or other matter found in the cream.

Waggons or other vehicles used by cream collectors should be equipped with suitable springs, in order to avoid, so far as possible, agitating the cream sufficiently to cause a partial churning. An undue loss of fat in the butter-milk, and butter with a weak, greasy body or grain, will be the probable result of allowing the churning process to commence while the cream is on the waggons. A light canvas top or covering for the waggons makes a good protection from the sun.

The Collector. The value and importance of a competent, reliable cream collector is too often underestimated by the factory management. In the first place it is necessary that he be strictly honest in his weighing or measuring and sampling. Secondly, he should be so well informed along general dairy lines, and possess such keen sense of taste and smell that the slightest "off" or objectionable flavor would be detected, and a probable remedy for the defect given in a quiet, pleasant, tactful manner. Thirdly, he should be neat and clean.

CREAM TESTING.

Cream varies in richness much more widely than does milk. The yield of butter per 100 pounds of cream sometimes goes as low as 12 or 15 pounds, and as high as 45 or 50 pounds.

When operating a hand separator the richness of cream produced may be caused to vary from day to day by a variation in one or more of the following conditions :

1. Speed of Separator. A high speed produces a richer cream than a lower speed.
2. Temperature of the milk at time of separating.
3. The feed of milk to the separator. The faster the milk is allowed to enter the bowl of the separator the lower will the cream test.
4. The amount of liquid used to flush the bowl. The same amount should be used each time.
5. The percentage of fat in the whole milk.

The most accurate method of determining the richness of cream is by means of the Babcock test, which is becoming quite generally adopted by many progressive creamery managers.

The system may be briefly outlined as follows : The collectors are provided with suitable bottles to enable them to take a sample of the cream supplied by each patron. It is well to have the sampling done on some particular basis. The size of sample taken should be proportionate to the weight of cream supplied, say, a fluid ounce for every 30 or 40 pounds cream. Upon arrival at the creamery these small samples should be examined for flavor and acidity, and then be transferred to composite sample jars, to which a small amount of preservative has been added. In this way the samples received during a month may be so thoroughly mixed together that a Babcock test made at the end of the month will give the average fat content of the cream supplied by a patron during that period.

As the Babcock test is based on weight, it is necessary to either weigh the cream or estimate the weight from the number of creamery inches. According to experiments conducted at the Ontario Agricultural College, an inch of average cream in a pail 12 inches in diameter will weigh 4.1 pounds. Thus, if it were found more convenient to measure the cream than to weigh it, the weight could be determined by multiplying the number of inches by 4.1. The number of pounds of cream furnished by a patron during a month, multiplied by the test, or the per cent. fat, and divided by 100 will give the number of pounds of fat which the cream contained.

REQUIREMENTS.

1. A Babcock tester. A 24-bottle steam turbine tester is the most satisfactory.
2. A double set of cream bottles (4 dozen), a portion graduated to read 30 per cent. and a portion 40 per cent.
3. An 18 c.c. pipette. A pipette graduated to 17.6 c.c. for milk, and 18 c.c. for cream is a convenience. The careful use of a sensitive scale which will weigh grams insures greater accuracy than measuring.
4. A supply of commercial sulphuric acid, which costs about 65 cents per gallon, or about 1-4 cent per test, and suitable acid measures.
5. A wooden case or rack that will hold 24 cream bottles. It is well to have a separate space or opening for each bottle.

6. Sufficient pint or half-pint milk bottles to furnish a composite sample jar for each patron.
7. Gummed labels bearing the patron's name, or number, should be pasted on the necks of the jars and coated with white shellac. This will prevent the labels being washed off.
8. The sample jars should have sound corks. Turned wooden corks are very satisfactory.
9. A supply of preservative in the form of tablets or powders, consisting of 7 parts of potassium bichromate to one part of corrosive sublimate.
10. Dividers or compasses to measure the fat column.

NOTES.

1. The quantity of preservative required for each sample jar is about what will lie on a ten-cent piece. This should be placed in the composite jar before the addition of any cream.
 2. The addition of each subsequent sample of cream should be followed by a rotary motion to thoroughly unite the fresh sample with the preservative.
 3. Sample jars should be kept well corked, and preferably in a cool place.
- A detailed outline of the Babcock test may be found in Bulletin 114 from the Ontario Agricultural College.

OIL TESTS.

The value of cream for butter making may be approximately estimated by means of the oil test, which is simply a churning process. The outlines of this method of testing are generally known, and call for only a passing reference.

The readiness with which a separation of the oil is effected from the serum is governed very largely by the degree of acid developed in the samples before the commencement of the churning process. This being true, it necessarily follows that ripe or sour samples of cream will give a higher or more satisfactory test than samples of fresh, sweet cream; thus, the oil test may be said to place a premium on sour cream.

As the Babcock test is rapidly displacing the oil test in cream-gathering creameries, it may be well to become familiar with the relation between the readings of the two tests.

Viewing this relation from the theory of the Oil Test, we have somewhat as follows: A standard creamery inch is one inch of cream (in a pail 12 inches in diameter) testing 100. One inch, therefore, contains $(\frac{12}{2})^2 \times 3.1416 \times 1$ equal to 113 cubic inches. One pound of butter contains about 25 cubic inches of butter oil, which is 22 per cent. of 113. Therefore, any sample of cream which will yield 22 per cent of its volume in butter oil should read 100 and make a pound of butter per inch. A reading of 100 by the oil test would, therefore, theoretically, be equal to 22 per cent of fat.

As viewed from the fat or Babcock test, we have the following: The overrun in cream-gathering creameries will probably range from 15 to 18 per cent. Then 100 pounds fat would yield 116.5 pounds butter.

One pound butter would require 100-116.5 pounds fat.

One inch of cream weighs 4.1 pounds.

Therefore, in order to yield one pound butter per inch :

4.1 lbs. cream must contain $\frac{100}{116.5}$ lbs. fat.

1 lb. cream must contain $\frac{100}{116.5} \times \frac{1}{4.1}$ lbs. fat.

100 lbs. cream must contain $\frac{100}{116.5} \times \frac{1}{4.1} \times 100$, equal to 20.98 lbs. fat.

Or practically 21 per cent. fat.

According to experiments conducted at the Ontario Agricultural College Dairy School, the actual percentage of fat in cream yielding one pound of butter per inch is 21.1 per cent.

More attention should be given to the dimensions of the drivers' pails, which have been found to vary from 11 1-2 to 13 inches in diameter. The bottom and the sides should be free from bulges. Weighing the cream insures greater accuracy than measuring. A single beam with a sliding poise, such as butchers use on delivery waggons, answers well.

The relation between the value of a pound of fat and a pound of butter may be found to vary somewhat according to the percentage of overrun obtained.

With an average overrun of 16.5 per cent. and butter worth 17 cents per pound, the value of a pound of fat may be estimated as follows :

A 16.5 per cent overrun would prove 100 lbs. fat to yield 116.5 lbs. butter.

116.5 lbs. butter at 17 cents equals \$19.805, then 100 lbs. fat must be worth \$19.80 ; therefore, 1 lb. fat must be worth $\frac{19.80}{100}$ equal to 19.8 cents.

If fat were worth 17 cents per lb., the value of 1 lb. butter would be estimated as follows :

100 lbs. fat at 17 cents, \$17.00 ; 100 lbs. fat will yield 116.5 lbs. butter ; therefore, 116.5 lbs. butter are worth \$17.00, then 1 lb. butter is worth $\frac{17.00}{116.5}$ equal to 14.58 cents.

Assuming the average overrun in cream-gathering creameries to be 16.5 per cent., the following relation will be found between the price of fat to the patron, and the price of butter according to the actual yield (not necessarily according to the oil test) :

Value of 1 lb. butter.	Value of 1 lb. fat.	Value of 1 lb. fat.	Value of 1 lb. butter.
cents.	cents.	cents.	cents.
15	17.47	15	12.87
16	18.64	16	13.73
17	19.81	17	14.59
18	20.98	18	15.45
19	22.15	19	16.31
20	23.32	20	17.17
		21	18.02
		22	18.87
		23	19.73

PASTEURIZATION.

The quality of butter produced by cream-gathering creameries would be improved by the adoption of pasteurization. This treatment, however, has proved relatively more beneficial to sweet cream than to cream which has been allowed to ripen. The pasteurization of ripe cream may be considered to be yet in an experimental stage.

The chief advantages of pasteurization are :

1. A butter of mild flavor may be produced, and food flavors largely overcome.

2. Better keeping qualities may be imparted to the butter.

3. Greater uniformity obtained in the product.

The following disadvantages are found :

1. An increase in the cost of manufacture, which may be accounted for in the cost of the outfit, labor involved and the expense of fuel.

2. The absolute necessity for good facilities for cooling. Where either water or ice is scarce, this adds considerable to the cost of manufacture. A pasteurizing plant is not complete without an effective continuous cooler.

The addition of from 10 to 20 per cent. of good culture will improve the butter made from pasteurized cream. As this increases the volume of cream for churning, it is well to have the fat content of the cream intended for pasteurization not lower than 30 per cent.

CHURNING.

The fat content of gathered cream is usually so low that a high churning temperature is necessary. This tends to cause an undue loss of fat in the buttermilk, as well as soft butter, which is likely to retain a high percentage of caseous matter and moisture.

Other conditions causing a loss in churning are : Making a churning from lots of cream which differ in temperature and degree of acidity, and also filling the churn too full.

The buttermilk should be allowed to drain well from the churn. It is well to add a pail or two of brine at this stage. Churns should be levelled to allow a free outlet.

Wash with water at a temperature which will give the butter the proper consistency for working and expelling the surplus moisture. It is well to give butter intended for export two washings.

Salting. Salt which has been sifted and is free from foreign flavor should be used in the proper proportion to meet the requirements of the markets. Care should be taken to distribute it uniformly.

Sometimes a preservative in the form of boracic acid in the proportion of one-half per cent. is used to improve the keeping quality of saltless butter.

Working. A more uniform distribution of the salt may be obtained by giving the churn a few revolutions before placing the rollers in motion. If, after partial working, the butter can be allowed to drain a short time without undue exposure, the more complete will the process be.

Packing. Butter intended for the export trade should be solidly packed in clean, tight packages, which have been well coated with paraffine, and lined with heavy parchment paper. If soaked several hours in a strong brine, to which formalin has been added there will be little tendency to mould. Care is necessary to insure a smooth finish without causing a greasy appearance on the surface. The paper ends, if kept moist, may be neatly and closely folded over the top of the package, so as to form a seal, thus excluding the air.

The length of time during which butter will retain its fine aroma depends very largely on the temperature of the storage in which it is held. A temperature not higher than 28 or 30 degrees F. should be maintained when butter is being held for two weeks.

A cold storage requires close attention in order to keep it clean and dry, and to insure a uniformly low temperature. The extreme variations in temperature may be readily noted if a self-registering maximum and minimum thermometer be kept in the cold storage.

It is not wise to hold butter more than a week in the average creamery cold storage. The depreciation in the actual worth of the butter usually more than offsets any rise in price.

THE CREAMERY BUILDING AND MACHINERY.

The building should be neatly and substantially built, preferably of cement brick or stone. If built of wood, the walls should be well insulated by the use of four to six thicknesses of lumber, two to four thicknesses of good building paper, and at least two "still-air" spaces. The outside should be neatly painted some light color, which will cause it to be cooler in summer. The floors should be made of cement. A wooden floor should not be used in a creamery, as it is almost impossible to prevent its leaking, and so harboring decaying organic matter. Old wooden floors should be replaced with cement as soon as possible. The cement should also extend up on the walls for at least six inches.

The ceiling of the making room should be at least twelve feet high. The inside of the creamery and cold storage should be coated with whitewash once a year. If not whitewashed, it should be painted, but the cold storage should be coated with shellac and not paint, owing to the smell from the paint which may taint the butter. When troubled with mould on the walls they should be thoroughly cleaned, then be sprayed with a solution of one part bichloride of mercury in one thousand parts of water.

The cream vats should have plenty of space for water and ice around the sides for cooling. The combined churn and worker saves labor, time, floor space, pulleys and belting, and can be recommended to those purchasing new churns and workers. All the machinery in a creamery requires extra good care, as otherwise it deteriorates in value very rapidly.

Ontario Agricultural College and Experimental Farm

SOME BACTERIAL DISEASES OF PLANTS
PREVALENT IN ONTARIO.

FIRE BLIGHT OR TWIG BLIGHT, BY F. C. HARRISON	
BACTERIOSIS OF BEANS, BY B. BARLOW	
SOFT ROT OF CAULIFLOWERS, FALL TURNIP, ETC., BY F. C. HARRISON	
SOFT ROT OF SWEDES OR YELLOW TURNIPS, BY F. C. HARRISON	
A ROT OF CELERY, BY B. BARLOW	

12 Illustrations (Figs. 3-12 original F. C. H.)

FIRE BLIGHT.

"That species of blight which is sometimes called the 'fire blight,' frequently destroys trees in the fullest apparent vigor and health, in



Fig. 1.—A pear orchard badly infected with Fire Blight.

a few hours turning the leaves suddenly brown, as if they had passed through a hot flame and causing a morbid matter to exude from the

pores of the bark of a black *ferruginous* appearance ; this happens throughout the whole course of the warm season—more frequently in weather both hot and moist.” So wrote William Coxe in a book on the “Cultivation of Fruit Trees,” published in 1817, which is said to be the oldest American book on fruit culture.

Nearly forty years before this we have a record of the disease mentioned in a letter written by one William Denning, who first saw the disease in the Highlands of the Hudson, in 1770. He described the disease fairly well, and thought it was due to a borer in the trunk of the tree.

From 1817 to almost the present time, we find in horticultural literature many theories as to the cause of the blight. It would be tedious to give an account of all the different theories put forward by various writers during this period. The most diverse views were entertained as to the cause of the disease, and it was a constant topic for discussion in the horticultural journals and societies. These discussions were so wearisome and so barren of results that the Western New York Society resolved that the subject should not be discussed at their meetings unless some one had something entirely new concerning the disease to communicate.

Amongst the different theories put forward to explain the cause of pear blight, we may mention the following :

1. Insects.
2. Rays of the sun passing through vapors.
3. Poor or deleterious soil.
4. Violent changes of the temperature of the air or the moisture in the soil.
5. Sudden change from sod to high tillage resulting in surfeit or overplus of sap.
6. The effects of age ; old varieties being most subject to it.
7. Autumn freezing of unripe wood, which engendered a poison which destroyed the shoots and branches in the following season.
8. Electricity, or atmospheric influence.
9. Freezing of the sap, or freezing of the bark.
10. The heat of the sun assisted by rain-drops acting as lenses causing the scalding of the sap and bursting of the cells.
11. Fermentation of the sap.
12. The absence of certain mineral matters in the soil.
13. An epidemic transmitted from place to place by the air.
14. Fungi.

Each of the above theories was sustained by various writers, and it may be of interest to note that Henry Ward Beecher was an advocate of the theory that the cause of blight was due to the autumn freezing of unripe wood.

A. J. Downing, the distinguished author of "Fruits and Fruit Trees of America," applied the name "Frozen-sap blight" to the disease. His theory was that the disease was due to the freezing and thawing of sap. The sap thus lost its vitality, became dark and discolored and poisonous to the plant.

Thomas Meehan, editor of the "Gardeners' Monthly," supported the idea that fungi were the cause of the disease; but no tests were applied to prove that the inoculation of these fungi into healthy trees would cause the disease. It was not until the year 1878, when W. T. Burrill, Professor of Botany in the University of Illinois, announced to the Horticultural Society of that State the discovery of bacteria, apparently connected with the disease. Burrill also proved that the disease was infectious, and could be communicated to healthy limbs by inoculation, using the gummy exudation from an affected tree as a virus. Not only was he able to produce the disease in pears, but also in apples and quinces. Dr. J. C. Arthur, Botanist of the New York Experimental Station, subsequently confirmed Prof. Burrill's results, and thoroughly established the fact that a certain species of micro-organism, named by the discoverer *Bacterium amylovorum* or the starch destroying bacterium, was the sole cause of the disease.

Geographical Distribution. This disease is peculiar to North America. So far it has never been recognized in Europe. Professor Budd, of Iowa, who is familiar with the disease as it occurs in North America, has inspected the orchards of Europe and states that no trace of fire blight of pear or apple trees can be seen in Europe. It is also unknown in New Zealand and Australia. In North America, the blight extends from New York to California and from the northern counties of Ontario to Texas.

Dr. Beadle, in a sketch of the history of the disease in Ontario, states that, "In the early days of fruit-growing in the Niagara district we had no pear tree blight nor apple tree blight. With the advent of what people termed grafted fruit there came, after a few years, 'blight' on the pear tree." "By the year 1840 it had spread considerably." N. J. Clinton, of Essex County; S. Hunter, of Oxford; E. D. Smith, of Wentworth; Stone and Wellington, of Welland; R. Hamilton, of Argenteuil, reported its presence in their respective counties about 35

years ago. The colder parts of the Province have suffered as severely from the disease as the more favoured districts. The orchard of the Dominion Experimental Farm, at Ottawa, has been attacked, and the 140 Russian variety of apples cultivated there have suffered severely. In warmer districts, however, the disease has been much more severe. Whole orchards have been completely destroyed in the State of Texas, and certain pear-growing districts in that State have been practically ruined by this parasite.

Losses. No statistics are available to give us an idea as to the amount of loss to fruit growers from pear blight, but a few references to losses by this destructive disease will help to give us an appreciation of the subject. Coxe, in 1817, reported that he had lost upwards of fifty trees in twenty years. In the years 1826, 1832, and 1844 there was an increased prevalence of the disease, and few pear orchards escaped without partial or total loss of many trees and some orchards were quite destroyed. Downing called it the "monstrous malady of the pear." Lyons stated, as the opinion of many cultivators in the State of Michigan, that "The pear tree cannot be grown with financial success on account of the blight." Hallam, in 1882, reported that, "In Southern Illinois, pears have failed—utterly failed—so that none are now cultivated for market. The blight has destroyed the trees, branch and root;" while A. Noice of the same State, doubted "if one-tenth of the pear trees that are planted lived ten years on account of this destructive agent." E. H. S. Dart stated that the severities of winter were not so much to be dreaded as the ravages of blight. He had in 1874 one to two thousand trees affected. Dr. P. A. Jewell, in 1876, lost 10,000 Tetefsky apple trees by it. Bailey, of Cornell, declared that fire blight was undoubtedly the most serious disease with which the quince grower had to contend. It is the same disease which is so destructive to pear orchards in certain years and to certain varieties of apples, particularly the crabs. Selby, of Ohio, reported that the disease ranks among the most destructive known to the orchardist in his State. Chester, of Delaware, announced that pear blight was of unusual severity during the season of 1901 and caused much alarm because of its rapid spread through the orchards of the State. In 1895 its ravages were most severe on apple trees in the vicinity of Hamilton and Burlington Bay. J. Craig gathered information as to the character of injury of the disease from fruit growers throughout this Province and a number of these state that the injury was very severe.

These citations are enough to show that the disease is of special economic importance and greatly dreaded by many fruit growers.

Symptoms. The first indication of fire blight is seen either in the browning and subsequent blackening of the leaves or of the young twigs or of the tender shoots. When the twigs or shoots are the principal parts affected the disease is spoken of as twig blight. Pears show the presence of the disease more frequently by the blighting and blackening of the leafy tufts of the spurs, and show it especially by the darkening of the blossom clusters on the larger clusters, while, later, the branches themselves become blackened. The progress of the disease is always downward—an inch or more each day, depending upon the season, until the larger branches are infected. In the more susceptible varieties it spreads more quickly, involving the whole tree; but in the more resistant varieties the progress of the disease is not so fast. When the disease is active the bark of the diseased branches cracks, and a thick, blackish, gummy fluid exudes, and later the infected bark becomes hardened, dry and shrunken. The disease occasionally appears on the larger branches and trunks of fruit trees when these have been bruised or otherwise injured, when its appearance is similar to the injury known as “sun-burn” or “sun-scald.” This disease of the trunks or larger branches is sometimes spoken of as “body blight” or “rough bark.” The inner bark and cambium layer of the limbs and trunk are the most important parts of the tree killed by the blight. Instances are known of its attacking the fruit, producing watery ulcers accompanied by brown discoloration and decay. The disease may be known by its peculiar odor, said by some writers to resemble putrefaction.

When the disease is in progress, the discolored blighted portion blends gradually into the color of the normal bark, but when the disease has stopped there is a sharp line of demarcation between the diseased and healthy portions. (Waite).

Microscopic Appearance of the Diseased Tissues. The most conspicuous change in the tissues affected with the blight is the disappearance of the stored starch, and on account of this peculiarity the organism has been named the “starch destroying bacillus” (*Bacterium amylovorum*). The germ penetrates from one cell to another and produces a gummy or mucilaginous matter which is found on the exterior of the affected parts. The microbe is found, as a rule, only in the inner bark and the actively growing tissues (called the cambium, which produces wood on the inner side and bark

on the outer side). The organism is unable to grow when the tissues are lignified or woody.

Life History of the Pear Blight Germ. The organism which produces the disease is a small motile bacillus, which increases with great rapidity in the succulent parts of affected trees. (Fig. 4). The microbe is of microscopic size, so small that 25,000 placed end to end would only measure an inch. They are able to live and multiply in the nectar of the blossoms, from whence they are carried to other flowers by bees and insects which visit the blossoms for honey and pollen. From this locality the germs extend into the tissues and then downward into the branches by way of the inner bark, girdling the limbs and causing a large amount of damage. The blight germ also gains entrance to the plant through the tips of growing shoots, thus producing twig blight. The organism is not killed by the winter frosts, but lives in the bark in a dormant condition until spring. As soon as the plant tissues become gorged with sap in the spring the microbes, which have remained alive all through the winter, start to grow and extend into the new bark. This new blight which develops in the spring can be recognized by its moist and fresh appearance from the blighted, dead and dried bark of the previous summer. A large amount of gum is exuded from the affected bark, and runs down the tree and attracts to it bees and other insects, which carry the microbes to the early blossoms, and from these first flowers it is carried to others, and thus the disease extends.

The germ has never been discovered in the soil, although careful search has been made; hence the importance of recognizing the winter form of the disease, for if these affected portions of the tree are cut out and destroyed, the pear blight question is solved, for without the microbes there can be no disease.

Conditions Affecting the Spread of the Disease. Fire blight differs in severity in different localities, and there are a number of conditions which affect the character and progress of the disease.

Every tree of the pome family is subject to the blight, but pears and quinces are more susceptible than plums and apples. The mountain ash, service berry and hawthorn are frequently diseased, but not to such an extent as the first named trees. There is a difference in the susceptibility of varieties. Thus, among pears, Clapp's Favorite, Flemish Beauty, and Bartlett are more liable to the disease than Keiffer and Duchess, and amongst apples, the Crab varieties are the least resistant.

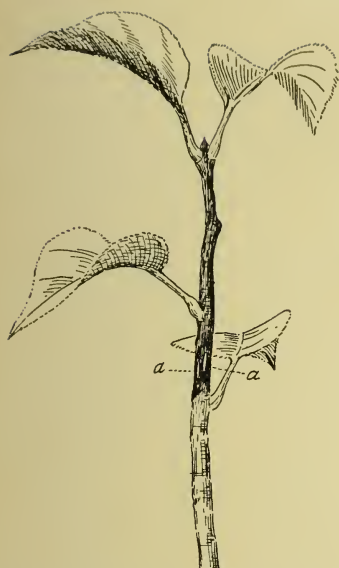


Fig. 2a.—Showing the result of inoculating a terminal shoot with a pure culture of the Fire Blight organism by puncture at the point *a*.



Fig. 2b.—Showing the blighting of a terminal shoot by inoculation of the terminal bud with a pure culture of the Fire Blight organism. (After Chester).

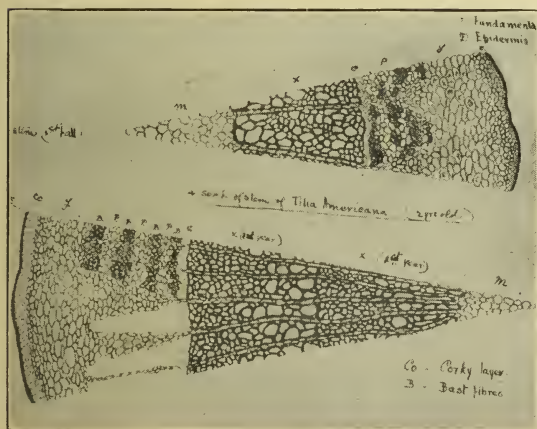


Fig. 3.—Cross section of a one and two year old stem. Fire blight bacteria grow in the cambium (c) and inner bark (F). E—epidermis. Co—Corky layer, B—Bast fibres, P—Parenchyma, C—Cambium. X—Xylem or woody tissue. M—Medulla or pith.



Fig. 4.—Fire Blight bacteria (*B. amylovorum*) x2000.

Climatic conditions influence the disease; warm, moist weather with much rain favour it, whilst bright, dry, sunny weather tends to check it.

High cultivation, rich soil, heavy manuring, free use of fertilizers, heavy pruning, or any other treatment which has a tendency to induce new and succulent growth, favors the disease, as the bacteria grow with far greater rapidity and penetrate more quickly from cell to cell when the tissues are gorged with sap. Insects are more partial to young succulent shoots and leaves, and the bites and punctures of such insects whose mouth parts may be contaminated with pear blight germs often serve to infect the tree.

It is thus manifest that healthy, thrifty, vigorous, well fed and well cultivated trees are more liable to the disease than others, and hence the severity of an attack of fire blight may be lessened by conditions which are under the control of the grower.

Treatment. The treatment of fire blight is of two kinds—that which is designed to put the tree in a condition to withstand the attack of the blight microbe, and those methods which aim at the extermination of the causal bacterium. Unfortunately all methods which are used for hindering the attack of the microbe consist of restraining the full development of the tree, and hence any such system of procedure should not be followed unless an orchard is very badly attacked.

High cultivation with pruning and the other conditions already mentioned as predisposing trees to blight should be avoided, but the trees should be allowed to ripen the wood, and in order to do this the fruit grower must use any method which will check the amount of moisture in the soil—for instance, by the growth of a clover crop.

The fire blight organism cannot be exterminated by spraying, as the microbe lives in the tissues beneath the outer bark, and it is impossible to reach it with any spraying solution, for, unless the bacteria come into contact with the germicide, spraying is ineffectual.

There is, therefore, but one remedy, to cut out and burn the affected parts of the tree. It is very necessary when cutting out a diseased branch or twig to cut well below the discolored portion, as the bacteria are in most cases far below the discolored portion, the discoloration not being produced immediately upon the appearance of a few bacteria, so that if only the discolored portion were cut off numbers of bacteria would still be left in the stump, and these would continue to multiply, and the disease would soon be evident again.

Cutting of affected parts may be done at any time in the winter

and spring, but it is not advisable to cut in the growing season, as fresh cases may be constantly occurring, and these, owing to lack of sufficient development, would not be seen.

The best time for cutting out affected branches is towards the fall, or when the trees have stopped forming new wood, when most of the blight has developed, and when the contrast between the discolored leaves and branches and healthy tissues is easily seen.

Trees should be carefully inspected for blight during the winter, and in spring before the blossoms come out, in order to destroy any affected parts that may have been missed at previous inspection.

All trees of the pome family in the vicinity should be examined as well, as these, if blighted, may serve to reinfect an orchard which has been carefully treated.

In cases where the bark of the trunk is affected, it can be cut out and the wound covered with a lead and oil paint. The cut surface of the branches over one-half inch in diameter should also be painted.

A BACTERIAL DISEASE OF BEANS.

Lima beans are not grown commercially in Ontario. Wax beans are grown in gardens and for canning. Field beans are grown extensively in the lake counties of Essex, Kent and Elgin, Blenheim and Ridgetown being centres of the bean industry.

A bacterial disease of beans is causing loss and injury in nearby bean-growing sections of the United States, from New Jersey to Michigan, and it is probable that it occurs in this Province. We have made some study of the disease under field conditions in Michigan and in our laboratory at the College.

The disease usually begins at the margin of the leaf, or where the leaf has been injured or torn by insects, wind, or hail. Here a yellow spot appears, and the green of the leaf is destroyed. The spot increases rather slowly, and the diseased tissues become brown, especially the minute veins, which become almost black.

This diseased part of the blade turns dry and brittle in the sun, and soft in the rain, and it may be broken away, leaving ragged holes and torn margins. The whole leaf may die and fall to the ground or remain withered on the stem. The disease enters the stem by way of the leaf stalk, and advances in the stem to other leaves and to the young pods. In severe cases the pod may wilt and die, and, on opening it, the half-grown seeds will be found shrivelled and dis-

colored. Most of the affected pods, however, reach full size, and the beans may be apparently sound or only slightly discolored at the seed scar, or they may be much discolored. The whole plant does not usually die outright, but lingers through the season

If we tear out a bit of tissue from a diseased spot in the leaf, crush it on clean glass, and examine it under the microscope, we shall find bacteria in very great numbers; they are so numerous that the diseased tissue seems to be a mass of bacteria, and all apparently of one kind—small, short rods, single, or joined end to end in twos. This germ, and the disease caused by it, were first described by Erwin Smith, and the name given to it is *Pseudomonas phaseoli*.



Fig. 5.—The bean plant inoculated with the bacillus which causes the disease. Showing the wilted leaves.

With proper care, we may tear open a stem, take a bit of diseased tissue, crush it in melted gelatin; and pour the whole into glass dishes. Here, the gelatin becomes solid, holding each germ apart from others, where it grows and multiplies, and in four days small, round, yellow spots or colonies appear. On examination these colonies are found to consist of bacteria like those in the diseased plant. We can now transplant a colony to various media and ob-

serve its growth in pure culture. By such methods, we have repeatedly got pure cultures from leaf, stem, pod and seed. The bacteria have been obtained alive from the seed coats of beans kept in the dry pods or in sterile test tubes over winter, and the same seeds have then germinated and grown.

During the past winter, we have inoculated more than twenty bean plants growing in pots in the laboratory. The surface to be inoculated was touched with a hot platinum needle and then punctured with a sharp, sterile platinum needle. The needle was then

touched into a pure culture of bacteria from the diseased beans and thrust again into the puncture. The puncture was closed and sealed with a loop of sterile, melted paraffin. Other punctures were made and covered in the same way but no bacteria were introduced. Every inoculated plant sickened and the same symptoms developed as were observed in the diseased plants in the field. Numerous check plants remained healthy. Plants inoculated in the stem showed symptoms after two or three weeks. At first, there is a yellow discoloration, spreading slowly from the point of inoculation. As the disease progresses, it enters the leaf by way of the leaf stalk and kills it. Finally, the whole plant may be killed or it may linger alive for months.

The leaf may be inoculated by puncturing the veins, but a better way is to inoculate in the petiolules, or short stalks of the individual leaflets. The disease most affects the woody bundles of leaf and stem, and all the woody bundles of the leaflet converge in the petiolule. A puncture in the petiolule causes no lasting injury but soon heals if no bacteria are introduced.

The needle, which



Fig. 6.—The bean plant inoculated with the bacillus which causes the disease. Showing the wilted leaves.

should be fine and sharp, is thrust into the petiolule from its upper end downward. Each of the three petiolules is thus punctured and the culture is then introduced into one or more of the punctures and all are closed with sterile, melted paraffin.

Some time will pass before any symptoms appear. In about three weeks, the inoculated leaflet droops on its stalk and wilts in the sunshine, but apparently recovers at night. There is a yellowing at the base of the blade; this spreads rapidly, following the veins. The affected tissues wilt, and the veins become dark brown. Within five days from the appearance of the first symptoms, the leaflet is dead and dry.

During this time, the leaflets of the same leaf which were punctured but not inoculated remain healthy, and it is nine or ten days, on the average, before the disease reaches them. In a few days more, these leaflets also are dead. The disease now travels down the main leaf stalk and enters the stem, where it progresses slowly from node to node, killing the leaves and finally it may kill the whole plant.

All inoculated plants developed the characteristic symptoms of the disease, and all were, at some period, examined for bacteria. The characteristic bacteria were found in every instance, and in all parts examined which showed the symptoms. Numerous check plants, kept under the same conditions, but not inoculated, showed no symptoms of the disease, but remained healthy and, on examination, no bacteria could be found in their tissues. Plate cultures from the diseased tissues of inoculated plants developed uniform pure cultures of the germ inoculated into them. Sections of the inoculated plants showed characteristic bacteria present within the cells and especially numerous within the woody bundles; the vessels being choked with them and the cell walls frequently dissolved.

PREVENTION.

No remedy is known for the disease after the symptoms once appear in the plant. Measures may be suggested, however, to prevent its introduction and spread. Seed containing the bacteria must not be planted. Such seed may be much discolored, may show slight evidence of infection, and for this reason seeds from fields where the bean plants have shown symptoms of the disease should not be planted, even though such seed has been carefully picked over and all discolored beans removed from it. This precaution in the selection of healthy seeds applies with special force to the planting of new fields where beans have not been grown. It is hoped that a method of treating the seed may be worked out, by which the bacteria may be surely killed without injury to the seed. This germ, *Pseudomonas phaseoli*, forms no spores and is readily killed in water heated to only 122° F., for ten minutes, a temperature which dry bean seed can endure for some time without injury. It is readily killed, also, by a solution of mercuric chloride, one part to 1,000 of water.

A field where beans have sickened with this disease is unfit for growing beans for at least one season, as the germs live over at least one winter in the stems and leaves left on the ground. How long such a field may remain infected is unknown, for we do not yet know

whether the germs can live and increase in the soil where no beans are growing, although this is probable.

Bean straw from infected fields may be burned. If it is fed to animals or used as bedding, the manure should be returned to the field on which the beans grew, and not spread on fields as yet free from the disease.

This Department will continue its work with the disease, and we hope to make a survey of the commercial bean-growing areas of the Province about the time of bean harvest this season. We shall be glad, at any rate, to examine diseased bean plants and seeds intended for planting.

SOFT ROT OF WHITE TURNIPS, CAULIFLOWERS, CABBAGES, ETC.

During the last few years we have examined a number of the soft rots, caused by several different kinds of microbes. In one case we made a special study of the causal organism, which proved to be a new species. Considerable study was devoted to a rot of Swedes which has caused much loss to farmers in different districts of the Province. We also found that one of the causes of a soft rot of celery was due to a common soil organism which heretofore had not been found able to produce disease in plants.

The soft rot of white turnips, cauliflowers, etc., has been rather common during the last few years. In 1901 much damage was done to market gardens in the vicinity of Guelph, and wherever white turnips were grown there was considerable rot during the season of 1901.

Cause. This soft rot is caused by a microbe—a bacillus or rod-like organism (scientific name, *Bacillus oleraceae*) which increases very rapidly when once it has gained admission to the plant. It secretes a substance which has the power or property of dissolving the cell wall of the plant. The cells are thus separated from one another, break down, and a soft, pulpy mass is the result. From this action of the microbes, the common name "Soft Rot" has originated.

Symptoms. The character of the rot is similar in all plants that are attacked. In the cauliflower, the head or edible part breaks down into a soft pulpy mass, brown to black in color, usually with an objectionable smell. Cabbages behave in a similar manner. In

turnips, the globular root is the portion of the plant that shows the most decay. The rot is brown in color, very soft, and with a dis-



Fig. 7.—*B. oleraceae*. The flagella stained by Van Ernegem's method. The bacteria were taken from an agar culture 18 hours old.



Fig. 8.—A healthy cauliflower plant; inoculated and grown under the same conditions as the inoculated plants.



Fig. 9.—Cauliflower plant inoculated by placing a piece of softened tissue, taken from the interior of an affected inoculated petiole, on the surface of the healthy flower. The flower is reduced to a pulpy, black mass. Five days from time of inoculation.

agreeable odor. The turnip leaves have a wilted appearance, owing to the fact that their supply of nourishment is cut off.

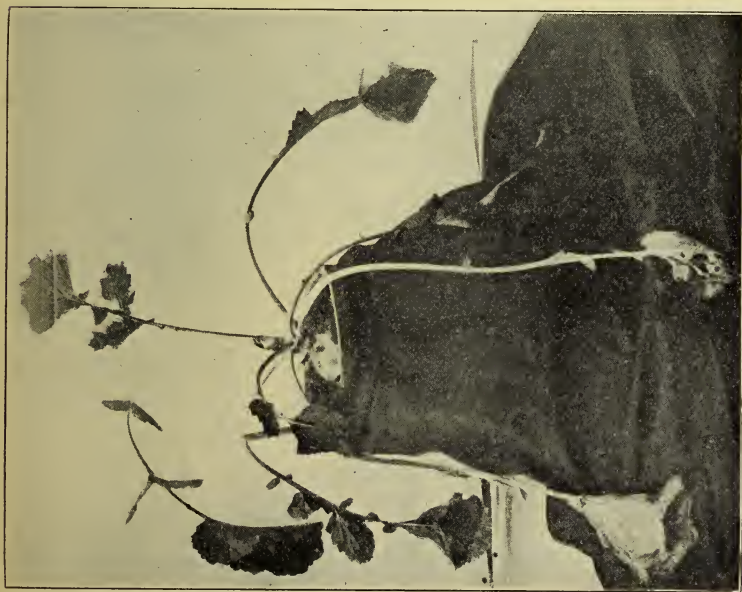


Fig. 10.—A white turnip plant inoculated at the crown from a pure culture of *B. oleraceae* by means of two needle punctures. The photograph shows the plant nine days after inoculation.

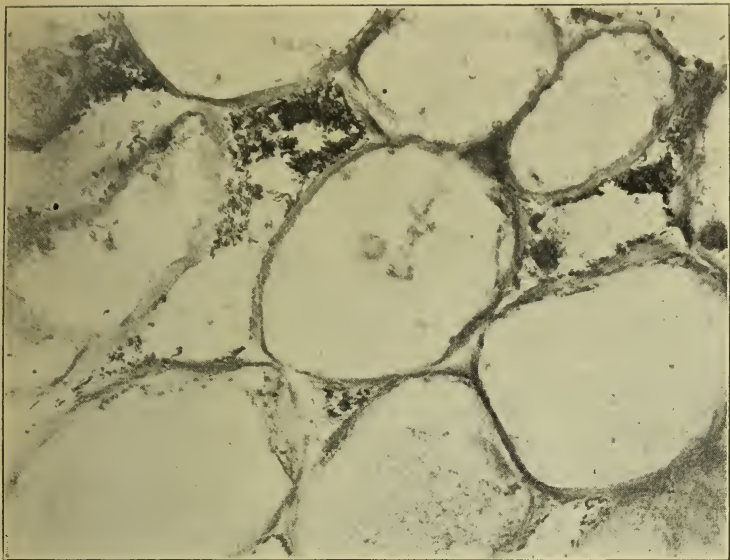


Fig. 11.—Cross section of part of the petiole of a diseased cauliflower inoculated with a pure culture of *B. oleraceae*. Note the bacteria in the intercellular spaces and their penetration along the middle lamella.

CONDITIONS AFFECTING THE SPREAD OF THE DISEASE.

1. *Meteorological Conditions.* Warm weather, combined with excessive moisture both of the soil and of the atmosphere, and the fact that transpiration is checked by this condition, undoubtedly play an important part in the spread of the rot amongst cauliflowers and turnips. Those seasons which are warmer and moister than the average predispose plants to rotting.

2. *Rankness of Growth.* The weather conditions above mentioned, and the plentiful use of manure by market gardeners and good cultivation, favor very quick, rank growth. The plants most affected are large and heavy, with many leaves shading the surrounding soil, thus conserving moisture and promoting quick growth.

3. *Abundance of Insect Pests.* The disease is chiefly spread by means of infection by wounds, and under field conditions these are usually produced by insects, especially the cabbage worm and turnip beetle. A careful examination of very many plants show that one or more insects are present on each plant. Slugs also do considerable damage. Ants and other insects swarm around turnips, eat the rotting pulp and no doubt serve to carry the germs to other plants.

4. *Injury from Planting, Cultivation, or Wounds.* Leaves of turnips are frequently bruised or injured during cultivation by either hand or horse hoes. Cauliflowers may be injured during planting out and the infecting organism brought into contact with the broken surface. In cases of very rank growth, heavy wind accompanied by rain may cause leaves to be broken off and thus afford bacteria a chance to penetrate into the plant tissues. Many gardeners trim their cauliflowers on the field, and when these are infected they carry the disease on to another season. The same ground is often used, year after year, for the same crops, a dangerous procedure when disease is present, as it is likely to carry over the trouble to other years.

5. *Susceptibility of Varieties.* Some varieties of turnips rot far more easily than others. Thus, the Yellow Aberdeen Green Top, the Yellow Globe, All Gold, etc., are usually far more rotted than a number of other varieties.

PREVENTION.

It is impossible to spray with any of the ordinary fungicides for this disease as the organism is in the interior of the plant, and the spray is only effective when it is actually brought into contact with the organism; hence spraying is of no use, and efforts are therefore to

be directed towards prevention rather than cure. The following methods will serve to check the disease :

1. The use of rotation by which other crops are grown on infected soil for a number of years.

2. Control of insect pests as these serve to spread the disease.

3. In the case of cauliflowers and white turnips, destined for immediate consumption, early harvesting of the crop is recommended, as the disease is worse when the plants are approaching maturity.

4. In cases where the turnips are stored they should be placed in a well-ventilated and dry cellar in which the temperature can be controlled. The minimum temperature for growth of the germ is about 45° ; hence if the cellar can be cooled to this temperature no rot will take place.

5. The planting of immune varieties. There are a number of varieties which do not seem subject to the rot, thus the Jersey Navet is almost immune and, under field conditions, the following varieties show less than 5 per cent. of rot : Greystone Improved, Purple Top Mammoth, Early American Purple Top, White Egg, White Lily, Red Top.

SOFT ROT OF SWEDE OR YELLOW TURNIPS.

This disease of Swedes has been observed in the Province for a number of years. In the year 1896, considerable damage was done to the turnip crop before the time of harvesting by soft rot. In many cases the turnips which had been culled out as unfit for storage were left out in the field and were ploughed down in future cultivation, and thus the soil was infected. The turnip crop of 1902 was also infected with rot. Many farmers estimated their loss that season at about one-third of the entire crop. The disease was particularly bad in the London district.

Cause. This rot is also caused by a microbe which has a similar action on the plant to the organism already described as being the cause of the soft rot of white turnips.

Symptoms. Growing Swedes affected with the rot are usually distinguished from the sound turnips by the appearance of the leaves. At first the lower leaves become flabby and have a dull green color which gradually changes to a yellow shade as the leaves dry. The lower leaves appear to be the first affected, and the growth continues in the upper or middle leaves as the lower ones drop off, thus producing what is commonly called "necky turnips." The plant by this

time is badly dwarfed and the top nearly dead except for two or three stunted, small leaves in the centre of the top. A softening of the tissue of the turnip now appears around the crown of the plant, which continues to increase until the whole turnip becomes a soft spongy mass with a disagreeable odor. The odor is caused by the decomposition of the tissues and the formation of aromatic compounds.

CONDITIONS AFFECTING THE SPREAD OF THE DISEASE.

The seasons in which this disease was bad were cooler than our usual summer weather, and the amount of rainfall was in excess of the usual amount. In the month of October, 1902, there was a heavy rainfall which probably extended the growing season of the turnip; and the unripe and damp condition of the turnips when harvested, together with the warm weather which followed the storing of the turnips, proved very favorable for the development of the disease.

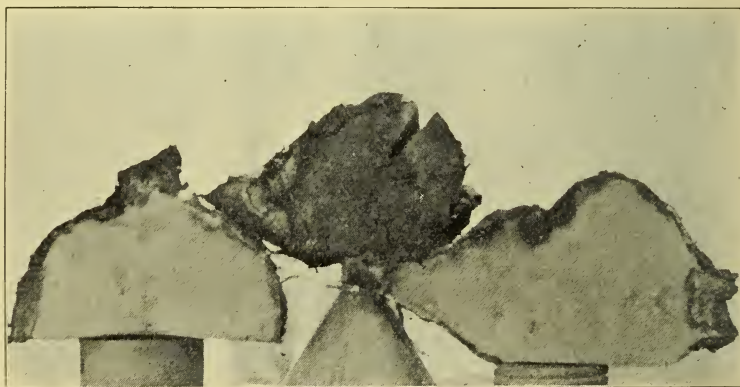


Fig. 12.—Swede Turnip affected with soft rot.

Other conditions affecting the spread of the disease are the same as those mentioned above.

PREVENTION.

If roots are properly ripened and cured they are not so liable to the rot when stored as are the roots which are either unripe or improperly cured, or both. When roots are taken from the field in a wet condition and directly stored in the cellar more rot is liable to be found. The temperature after the crop is stored has also a considerable effect upon the growth of the rot if it should happen to be present in the roots and a great deal of rot in stored roots would be avoided if the cellars in which the roots were stored were properly ventilated.

If the cellar adjoins the stable, a great deal of dampness gets into the cellar from the moisture from the cattle stable. This not only adds moisture to the air of the cellar but also raises the temperature.

Affected turnips should not be left out on fields to spread the disease to a following season; but should be gathered and burned, and in the same way the roots in which the rot develops after harvesting should be burned and not thrown upon the manure heap to infect the manure first and then the field to which the manure is applied.

The harvesting of the root crop should be delayed as late as possible in order to allow the crop to become thoroughly ripened. After pulling, the roots should be allowed to dry off before being stored.

A ROT OF STORED CELERY.

Celery may be dug in the fall and stored in a cellar to be used during winter and spring. It is usual to pack it closely, with the roots in soil which is kept moist. With right conditions of moisture and temperature the celery keeps well until spring, but, if the soil is wet, and the temperature varies, and, especially, if the celery freezes and thaws, it will decay.

Decay follows close upon death. The bacteria and moulds are its active agents. They are always present in the soil in which the celery grows, and in the soil in which the roots are packed, and there are no practicable means by which they can be kept away from the plant; neither can they be killed without killing the plant. It remains then to keep the celery alive and in health so that it can resist the invasion of the bacteria. A constant temperature, a little above freezing, keeps the celery alive without growing, and keeps the bacteria in check, for they also become dormant at low temperatures, and increases slowly, or not at all. If the celery freezes it becomes so much dead matter without resistance, fit food for bacteria, and, as soon as the temperature rises, the celery rots.

This was observed in some celery stored in the cellar of the Horticultural department of the Ontario Agricultural College during the winter of 1903-4. The celery tops showed signs of having been frozen, but, as the temperature continued low, it remained sound within, the outer leaves and stalks only showing signs of decay. On staining the decayed tissue, bacteria were found in large numbers, and, on making plates from the inner parts of the decayed stems,

many colonies developed. The plates were usually pure cultures, or almost pure cultures, of *Ps. fluorescens*, and two varieties of it were recognized. This is a rod-shaped organism, and is one of the commonest microbes found in water and soil; it is not usually associated with plant diseases. Two varieties of the germ were recognized, one from stems becoming brownish to amber in color in rotting, and the other from stems showing a greenish-blue color in rotting. Both varieties liquefy gelatin with green-yellow fluoresce. Some fresh plants of celery were obtained, and the outer leaves were cut away. The inner leaves were washed under the tap, and covered with mercuric chloride solution, one part to a thousand of water, then rinsed in sterile water and each stem put into a large sterile test tube containing a little sterile water in the bottom. In three weeks, four out of fourteen stems so prepared showed signs of rotting, but some remained sound after a month, and were then inoculated with pure cultures originally isolated from the celery. Some of these stems in test tubes had been standing in the sunshine and had regained their green color. To inoculate them a sterile platinum needle was dipped into the pure culture and thrust into the stem. After one day at room temperature the rot was sometimes evident, and, in about four days, juice from the rotting stem had accumulated in the bottom of the test tube, and the stem was softened throughout so that it could be shaken down into a soft pulp in the bottom of the test tube. Plates from such inoculated and rotted stems developed colonies of *Ps. fluorescens* in pure cultures.

While the weather continued cold the celery in the cellar remained sound, although it developed a sweet taste; but, when warm weather came in early spring, what had not been consumed, rotted.

By such study we learn that bacteria cause decay, and that decay takes place under conditions in some measures known to us and under our control. To keep celery well it should be packed with the roots in clean soil. For this purpose it is best to use the humus, or muck soil, in which the celery is commonly grown. The soil in which the roots are packed should be kept moist, but not wet, with good water. The cellar or storage room should be kept at a uniform low temperature, a little above freezing. Free ventilation should be provided, both as a means of regulating the temperature and for the health of the plants. It should be remembered, also, that celery kept in a close, foul atmosphere becomes tainted.

Ontario Agricultural College and Experimental Farm

A Bacterial Disease of Cauliflower (*Brassica oleracea*) and Allied Plants.

By F. C. HARRISON, Professor of Bacteriology.

In the summer of 1901, a market gardener, in the vicinity of Guelph, who made a specialty of growing cauliflowers, complained of a disease which was affecting his plants. Shortly afterwards the cauliflowers in the garden department of the College were also found to be infected, while further investigation in the neighborhood showed that a disease, or rot, of cauliflowers, cabbages and white turnips was quite general and had done considerable damage to these crops.

In the case of the market gardener referred to, more than half of his plants were affected, while in the College garden, about 5 per cent. of the plants were diseased.

Some 40 varieties of white turnips were tested on the trial grounds at Guelph, and most of them were more or less affected with the rot, the percentage of decayed roots varying with the variety, in some cases reaching as high as 64 per cent. The few farmers in the Province, who experimented with the varieties of white turnips that were sent out from this Experiment Station, reported a considerable amount of soft rot.

Later in the same summer I visited a number of farms in the vicinity of Woodstock, and found a varying percentage of white turnips rotting in the fields, although the Swede turnips were not affected, and from conversation with a number of farmers who visited us during the past season, I also gathered that wherever white turnips were grown there was considerable rot during the season of 1901.

PATHOGENESIS.

In order to positively demonstrate that the organism isolated from the cauliflower and turnip was the cause of the rotting, the usual requirements were worked out.

1. *Constant association of the Bacillus with the Disease (named Bacillus oleraceae and subsequently described).*

The same bacillus was isolated from diseased cauliflowers from the vicinity of Guelph, and from the garden department of the

College; from diseased white turnips of several varieties taken from the trial grounds of the Experimental Department, and from other parts of the Province, and also from cabbages growing next to the diseased cauliflowers in the garden department

This organism was also found in large numbers on the plate cultures, sometimes in pure culture, at other times in mixed culture, the most common contaminating organism being the *Bacillus fluorescens liquefaciens*. The rot bacillus was so numerous that a loopful of the rotted or pulpy tissue had to be very largely diluted in order to reduce the numbers on the culture plates to about 60-100 colonies per plate. In all these cases, no fungi were present and no mycelium was ever seen.

W. Lochhead, Professor of Biology at the College, who also examined some of the cauliflower material, was also unable to find any mycelium of fungi.

2. *Isolation of the organism and study in pure cultures.*

The isolation of the causal bacillus was quite easy, as it grew well in ordinary 10 per cent. beef peptone gelatine. The bacillus, whether isolated from diseased cauliflower, turnip or cabbage, or from different plants and varieties of the above plants, showed the same characteristics when grown on various media. Comparative studies of the various germs, isolated from different sources, were made, but no essential morphological or cultural differences were noticed. Bouillon,* 10 per cent. gelatine, agar, milk, potato, raw and cooked, raw cabbage stems, raw turnip and raw cauliflower were used in this comparative study.

3. *The pure culture of Bacillus oleraceae when introduced into susceptible plants produced the characteristic symptoms of the disease.*

A series of inoculation and cross inoculation experiments were made in order to substantiate the relation of the bacillus to the disease. Thus a series of cauliflower, turnip and cabbage plants were inoculated in the following manner :—

*These terms, when not otherwise stated, refer to media prepared in accordance with the recommendations of the Laboratory Committee of the American Public Health Association.

Inoculated with a pure culture of the *Bacillus oleraceae* from

—	Cauliflower.	Turnip.	Cabbage.
Cauliflower.....	x	x	x
Turnip	x	x	x
Cabbage.....	x	x	x

Positive results were obtained in each case, with the characteristic symptoms of the disease, viz., rotting and blackening of the leaves and stem.

These plants were all kept under favorable conditions for the spread of the rot. These conditions are described at length later on in this paper.

4. *The diseased, or rotted, tissues contained the Bacillus oleraceae in huge numbers.*

While their distribution and effect on the tissues was the same as that met with under ordinary field conditions, and re-isolation proved beyond doubt that it was identical with the organism which was inoculated.

5. *The chemical products of the organism also produced the characteristic symptoms of the disease.*

The bacillus was grown on raw turnips and cabbage until all the tissues were completely rotted, and the rotted material was then pressed and the juice extracted and forced through a Chamberland filter. This filtrate, which was found to be sterile, produced softening and rotting when placed on cut surfaces of raw potato, turnip, cauliflower and cabbage. Control cultures of these vegetables, kept under the same conditions as the inoculated slices, remained sterile.

PATHOLOGICAL HISTOLOGY.

A microscopical examination of the soft pulp from cauliflowers and turnips showed the presence of enormous numbers of bacteria. No mycelium or fungus spores were present. The bacteria were actively motile. In fresh preparations, free plant cells were visible and many were much disorganized.

A large variety of diseased tissues were fixed in a saturated solution of corrosive sublimate in 94 per cent alcohol, and subsequently imbedded in paraffin. Some 400 sections were cut from various

diseased parts of cauliflower and turnip plants, and were stained by various methods. The most satisfactory results were obtained by staining over night in carbol fuchsin, washing out the surplus stain first with water, and then with 97 per cent. alcohol, clearing in oil of cloves and mounting in Canada balsam. A number of sections were also stained with anilin blue. The latter method gave fair results; but the former method was the more satisfactory.

Completely rotten cauliflower or turnip was difficult—in fact it was almost impossible—to imbed in paraffin, as the whole mass fell to pieces when thrown into alcohol. Portions of petiole, stem, or flower of cauliflower, where the disease was just starting and pieces of tissue in a more advanced stage from which most of the soft parts had been cut away, furnished the best material for study.

Cross sections showed the bacteria in the intercellular spaces, where they increased rapidly and as soon as sufficient enzyme was elaborated, it softened the middle lamella and permitted the bacteria to penetrate between the cells. These enzymes had a marked action on the cell-wall, which gradually swelled up and lost all trace of its striated character. The cell wall at this stage also lost very largely its faculty of taking up the stain, and sections stained with carbol fuchsin showed the enormously thickened cell-wall, faintly stained a pale pink, while adjacent healthy cell-walls were deep red in color and showed very plainly the middle lamella and striations.

The figures 9-10 show the different stages in the destruction of the cells by this bacillus. Fig. 9 shows the bacteria in some numbers in the intercellular spaces, some are just beginning to penetrate along the middle lamella. At this period, the cell-wall is stained deeply. The last stage, just before the absolute collapse of the tissues, may be seen in Fig. 10, in which the lumen of the cells is very small due to the enlarging and softening of the cell-walls which now stain even more faintly than before. The bacteria have also enormously increased.

Sections of pieces of turnips affected with the rot, showed, slightly different features; although the action of the bacillus was the same.

Turnip cells have much thinner walls than the cauliflower petiole, or stem; consequently, when attacked with rot they collapse

more rapidly, and the marked swelling which we see in the cauliflower is either absent or less well developed.

Fig. 11 shows the bacteria in the intercellular spaces, the slight swelling of the cell walls and the beginning of the disorganization of the cells.

INOCULATION EXPERIMENTS.

It was found impossible to perform trustworthy inoculation experiments with plants grown in the field, as in this locality the white turnips and cauliflowers were more or less affected with the rot, hence it was necessary to grow fresh plants, from clean seed, in soil which had never been used for growing these plants. On account of the lateness of the season, the plants were grown under glass and all the following experiments, unless otherwise stated were conducted on pot-grown plants in a greenhouse with an average day temperature of 20-25° C.

Series I.

Three plants each, of cabbage, cauliflower, rape, white turnip, swede turnip and kale were inoculated with needle punctures through the parenchyma of the leaves. The platinum needle was dipped into a twenty-four hour bouillon culture of the organism, and from three to five punctures were made on one or two leaves of each plant.

RESULTS :—

Cabbage. In two days, the inoculated leaves were flaccid and whitish brown in the vicinity of the punctures. This area increased slowly for five days and then dried out.

Cauliflower. In two day, there was a flaccid, papery area surrounding the punctures; in five days, all leaves were rotted and had dropped down parallel with the stem of the plant.

There was no subsequent infection of the stems; the leaves gradually dried off at the base of their petioles.

Rape. No results followed inoculation.

White Turnip. Slight infection was produced around the punctures; but the lack of moisture seemed to hinder further growth.

Swede Turnip. No results followed the inoculation.

Kale. No results followed the inoculation.

Control Plants of each species, pricked with a sterilized needle remained perfectly healthy.

This series, therefore, showed that the inoculation of the germ made with needle pricks in the parenchyma of the leaves, produced more or less disease in cauliflower, cabbage and white turnips. The absence of sufficient moisture in the greenhouse, however, prevented the disease from becoming thoroughly established.

Series II.

This series was a duplicate of Series 1, only an agar culture of the organism was used instead of a bouillon culture.

The results were similar to those in series 1, with the exception of the Swedes, which became slightly infected. In one plant, a whole leaf rotted and fell off the plant; but the petiole subsequently dried off.

Series III.

In this series, three plants each of cabbage, cauliflower, rape, white turnip, Swede turnip and kale, were inoculated with needle punctures through the veins of the leaves. The needle was dipped in a 24 hour old bouillon culture, and from 3 to 7 punctures were made on one or two leaves of each plant.

Control plants were punctured in the same manner; but with a sterilized needle.

RESULTS:—

Cabbage. In two plants there was no apparent change; in the other plant a small cavity 15 m.m. long and 5 m.m. wide had been formed on the mid-rib by the rotting of the cells; but this subsequently dried out and the leaf remained healthy.

Cauliflower. No results followed the punctures of the veins and mid-rib.

Rape. In ten days, the leaves of all three plants were slightly affected, the vein was split, and a watery exudation was present on the surface. The inoculated leaves began to droop; but the disease progressed no further, and the wound became callused and partly healed.

White Turnip. The inoculated leaves behaved in exactly the same manner as the inoculated rape leaves.

Swede Turnips. No results followed the punctures of veins and mid-rib.

Kale. No results followed the punctures of veins and mid-rib.

This series, as a whole, gave less harmful results than the inoculation of the parenchyma. In cabbage, rape, and white turnip some slight disease symptoms were produced; but there was no general infection of the plant. Lack of moisture seemed again to prevent the rapid development of the disease and perhaps the different composition of the vascular cells hindered the formation of cell-destroying enzymes.

Series IV.

In this series, three plants of each of the five species already mentioned were used. A small portion of the epidermis on the upper part of the base of a leaf-stalk was removed and two loopfuls of a bouillon culture were rubbed on the exposed portion.

RESULTS:—

Cabbage. The leaf-stalk rotted through in three days and the leaf fell off from its own weight. The rotting did not effect the stem, as the diseased tissue dried out.

Cauliflower. There was slight rotting, or softening, in two days, and in five days the leaf rotted off, and the portion next to the stem dried up.

Rape. Slight rotting occurred for three days, when the wound dried up.

White Turnip. In two days, the softening of the tissues at point of inoculation had extended across the petiole. In five days, the leaf fell off, the rotting extending all through the stalk. The infected base then dried and healed.

Swede Turnip. Behaved the same way as the white variety.

Kale. In three days, the leaves were so much rotted through that its own weight caused it to break off. The wound then dried up.

Control Plants with the epidermis removed, but with no inoculation, remained healthy.

In the above account of this series, the results are given for only one plant of each species, the two remaining plants of each lot behaved in a similar manner. These plants showed considerably more disease than those inoculated by vein or parenchyma punctures. This was probably owing to more moisture being present. At the juncture of the stalk with the stem, small drops of water would collect from the leaf surface, thus providing more moisture for the bacteria. As soon

as the leaf had rotted off, or fallen by its own weight, no more water collected in the angle of leaf and stem and the tissues rapidly dried up.

Series V.

In this series one plant of each of the species already mentioned, was used.

The lowest leaf of each plant was cut off, about an inch from its juncture with the stem. The cut surface was then rubbed over with a platinum loop, charged from a bouillon culture of the organism. Check plants received the same treatment, without inoculation. The results were very similar to Series IV. and need not be repeated in detail. Rotting usually extended downwards toward the stem for about half an inch, or even as far as the juncture with the stem, and then dried ont. The check plants showed no signs of rotting.

Series VI.

Three cauliflower plants were inoculated at the base of the petiole with a bouillon culture by means of two or three needle pricks. In two days, there was rotting, the affected area being 3 x 7 m.m. One of these plants was then placed under a bell-jar and at the end of six days the incculated petiole and leaf were completely rotted, the leaf fell off in a mushy mass and the rot spread to the stem, infecting the whole plant.

The flower head, which was well developed and quite white, gradually changed to a brown color and then rotted. The plant was practically destroyed 14 days from infection.

The diseased area in the other two plants (kept in the same state except that no bell-jar covered them) gradually dried out, leaving a small hole caused by the rotting of the tissues.

Subsequently, this experiment was repeated several times with the same results, the plant under the bell-jar rotting leaf by leaf, with final rotting of the flower.

Fig. 2 shows the beginning of the rot, a leaf (the one inoculated) having rotted through at the base of the petiole and fallen off. The stem of the plant, just below the crown, was darkened, due to the softening and discoloration of the tissues and the lower leaves are beginning to wilt, owing to the cutting off of their supply of nourishment. The leaves of the healthy plant, as shown in Fig. 1, are erect and rigid and comparison with the inoculated plant in Fig. 2 shows

the different position of the infected leaves which gradually declined until they were at a right angle with the stem and finally fell or broke off at the base of the petiole.

Fig. 3 shows a plant at a later stage. Most of the leaves are affected and the flower has become brown, and a part of it has completely rotted to a pulpy mass.

Summary. The experiments made in this series plainly show the relation of a humid atmosphere to the disease. When the air is full of moisture, it affords the best conditions for the rapid growth of the micro-organism on the exterior of the plant and it favors the production of a large amount of cytase-like enzyme which quickly causes the softening and destruction of the tissues.

Series VII.

Under field conditions, one frequently noticed that the leaves seemed perfectly healthy; but the flower was affected. This fact seemed to point to the probability that the flower-head might be very susceptible to the disease; or that the organism might be able to penetrate the unbroken epidermis. In order to test these points, three well developed cauliflower plants were infected in the following manner:

No. 1.—Water drops on the leaves were inoculated with a twenty-four hour old bouillon culture.

No. 2.—A small piece of softened tissue, taken from the interior of an affected petiole with a sterilized wire, was laid on the surface of the healthy flower.

No. 3.—A loopful of bacteria, taken from the surface of an agar-slope culture 24 hours old, was gently rubbed over a portion of the dry surface of the flower.

Two check plants were well watered with a syringe and kept under the same conditions as the above, viz., in the warm greenhouse, which has a very humid atmosphere, and an average day temperature of 28 degrees to 34 degrees C, and a night temperature some 10 degrees lower.

RESULTS :—

In two days, No. 1 showed slight discoloration of the treated area. In four days, softening commenced; and in 8 days the whole flower was a pulpy mass.

No. 2 behaved in a similar manner, but the discoloration and softening started earlier and the flower was reduced to a pulpy,

blackish mass in 6 days from the time of inoculation. Fig. 4 is a photograph of this plant on the fifth day, the whole flower mass having dropped and turned black.

No. 3 showed no signs of disease even after fourteen days.

N. B.—No water was syringed on the flower of this plant.

The check plants were syringed every day and remained absolutely healthy.

Summary: These experiments seem to show that, provided sufficient moisture is present on the interior of the flower of the cauliflower, infection by *Bacillus oleraceae* can and does take place. If small portions of the rotted tissues were placed upon the flower of healthy plants, infection took place, in spite of the mechanical resistance of the cuticle and epidermal cells. Many plants, under field conditions, were found with the flower alone infected.

Series VIII.

In this series three healthy white turnips (Greystone variety) were inoculated at the crown with two needle punctures. A check plant was treated in a similar manner, but with a sterilized needle.

Nothing was noticeable for two days; but on the third day, a small drop of water was exuding from each puncture of the inoculated plant and on the fifth day, rotting to a depth of 5 m.m. had taken place. In 14 days, the plants were dead, Fig. 8 is a photo of one of these plants 9 days after inoculation.

The check plant remained perfectly sound and healthy.

Subsequently the experiment was repeated, with the same results. Fig. 6 shows the extent of the rotting process, 6 days after inoculating with one needle puncture while Fig. 7 shows the most complete rotting 10 days after inoculation.

The Greystone turnip in all the inoculations was very susceptible to this disease.

Series IX.

Three healthy Swede turnips were inoculated at the crown with two needle punctures. A check plant was treated in a similar manner; but the punctures were made with a sterilized needle.

Two days after inoculation, there was a slight softening of about 2 m.m. in diameter around the puncture. In five days the area was only slightly larger and there was no further increase of the disease; although the plants were kept under observation for three weeks.

The check plants remained sound.

Subsequently this experiment was carried out in the tropical house, in a warmer and moister atmosphere. The results of the inoculation were, however, the same as before, a slight local rotting, followed by a gradual drying up of the infected area.

It seems that although the Swede turnip is not wholly immune; yet it has considerable natural immunity from this disease. This is proved partly from the experimental data above presented, and partly from the fact that we found very little disease among Swede turnips growing in the fields; although on our own grounds, some lots of Swede turnips were growing alongside white turnips which were very badly infected with the disease.

Series X.

In this series, two white turnip plants and two cauliflower plants were watered with about half a litre of water in which a bouillon culture of the *Bacillus oleraceae* had been poured. This watering was again repeated two days later and all the plants, including two check plants, watered without the addition of culture were kept under observation for about five weeks. No disease developed in any of the plants, which seems to indicate that the *Bacillus oleraceae* does not gain entrance to the plants through the root hairs.

One of the turnip plants of this series was subsequently inoculated at the crown and rotting followed in the course of a few days, thus showing that the turnip plant is susceptible to the disease.

Series XI.—The Virulence of Old Cultures.

In order to test the pathogenic power of old culture, both a cauliflower and a white turnip were inoculated with an agar culture of the rot bacillus, 2 1-2 months old, being the seventh transfer after isolation.* The cauliflower was inoculated, by means of needle pricks in the leaf, and kept in warm, moist place. In three days the first signs of rotting were noticed and the disease subsequently ran its usual course, ending in the complete destruction of the plant.

The turnip was inoculated with a puncture at the crown, which gave rise to the rotting and final destruction of the plant.

Summary: These experiments prove that the bacillus is able to retain its virulence, for a considerable length of time, in artificial agar cultures.

* I have since tried the virulence of cultures which have been on agar for more than 18 months. The cultures produced the characteristic rot in inoculated plants.

INOCULATION OF FRESHLY GATHERED VEGETABLES.

In all the following experiments, the vegetables were obtained fresh from the garden. These vegetables were thoroughly washed in running tap water and then, by means of sterilized cool knife, slices were cut and placed in Petri dishes. These slices were immediately inoculated by rubbing a platinum loop, (which had been charged with a bouillon culture) over their surface. In all cases, uninoculated slices of the different vegetables were also kept in order to check any contamination from germs growing on the surface, or from those which might develop from insufficient care in the preparation of the slices. In no cases did such uninoculated slices decay or rot.

All the cultures were kept at room temperature, which varied from 20-28° C.

Cauliflower. The whole plant, after rinsing, was cut down the centre and placed in a large dish, and then inoculated. In two days, the stem and flower had discolored to a dirty brown, and softening extended downwards about 20 m. m. There was a very disagreeable smell. In 7 days, the whole of the plant was completely rotted could be cut down and across with a platinum needle and the dirty brown color was darker. Gas bubbles were present in all the decayed parts,

Cabbage. Cabbage plants, treated like the cauliflower, underwent the same change and in 7 days there was a complete softening of the whole plant, with the production of a very bad odour.

Turnip (White). In two days a whitish wet growth spread over the surface of the slice. There was a pale brown discoloration of the infected part. The rot extended downwards to a depth of 10 m. m. In 5 days, complete softening had occurred. The smell was slightly disagreeable.

Turnip (Swede). Decay in the yellow turnip was usually slower than in the white, but depended largely on the amount of moisture present. Where the turnip was very moist, decay advanced rapidly; but on drier surfaces decay was slower, and at times no growth took place.

There was considerable exudation of water on the inoculated part and abundant brown-black growth which softened to a depth of 4 m.m. After two days growth, gas bubbles were present. Frequently, a whitish moist growth was noticed instead of the brownish-black, due either to difference of water content or to difference of

variety. Observations were made on some thirty turnips of several different varieties.

Rape. In two days, there was a water soaked appearance, slight smell and slight softening. After 7 days, the slice, 12 m. m. thick, was completely softened, the odour was bad and on the surface a white, moist growth was present.

Radish. In 24 hours, the surface was covered with a copious watery exudate. The affected area was darkened and softened to a depth of 6 to 7 m. m. In two days, the radish had completely softened, was blackish in appearance with a thin, dirty white skin on the surface. The pigment of the skin was dissolved and colored the condensation water. In 6 days, the radish was completely dissolved, forming a thick, dark, liquid.

Parsnip. In two days, softening to a depth of 10 m. m. had occurred. There was considerable water lying in the form of drops on the inoculated portion. The growth on the surface was moist and yellowish white in color and around the growth the parsnip was brownish black. In 7 days, the slice, 12 m. m. thick, was completely softened. There was no smell.

Carrot. In two days, there was abundant growth (both on the red and yellow portions of the carrot) which was transparent and very wet, and the carrot had softened to a depth of 4 m. m. The growth on the surface subsequently became whitish, and complete softening occurred in 6 days. The yellow portion of the carrot was somewhat darkened. There was no smell.

Carrot. (White). Abundant, whitish green, sputum-like growth, raised and wet. Outside the growth, there was a yellow to yellowish brown discoloration, especially around the vascular ring and softening had occurred to a depth of 5 m. m. In 5 days, the slice was completely softened, and the odor was pungent.

Mangel. In two days there was a whitish growth on surface with slight softening. In 7 days, the softening had increased; but not to the same extent as on carrot or parsnip. There was also some discoloration.

Beet. No growth and no discoloration.

Sugar Beet. In 24 hours, no softening and no growth. In 48 hours, there was a very slight growth on the surface while the softening was scarcely .1 m.m. in depth. In three days, the growth increased, was white and moist; but there was very little, if any

increase in softening. No further growth took place even on slices kept for 10 to 20 days.

Potato. It grew with great rapidity on raw potato, in the form of a moist, creamy, yellow, spreading growth with marked softening. In five days, slices 20 m.m. thick were completely softened and could be cut with a platinum needle. There was a depression in the centre and an ammoniacal smell. Nessler's reagent gave a distinct coloration to the water extract of the inoculated potato, indicating the presence of ammonia. Tincture of iodine did not color the inoculated potato blue, the starch was, therefore, destroyed.

Celery. In two days there was a moist whitish growth with yellowish discoloration and considerable softening. In 7 days the softening was more extensive and the discoloration brown.

Tomato. (ripe). After two days, there was a slight growth at seat of inoculation. In 7 days there was rotting and cracking of the skin with whitish growth extending from the cracks. The inside was quite soft.

Green Tomato behaved in the same way, but growth was somewhat quicker. The first indication of the disease was slight discoloration or premature ripening of the inoculated part followed by exudation of water and softening and later by cracking of the skin and progressive softening.

Artichoke. (Jerusalem). In 24 hours the surface growth was moist and dirty white in color, and there was softening beneath surface to a depth of about 7 m.m. outside the circle of growth the tuber had become red brown in color. In 48 hours the softening was deeper with pitting of the affected portion. Color around the affected portion became reddish. In 4 days the whole tuber was soft.

Asparagus. The upper third portion of the Asparagus stem (the edible part) was the first part to rot, presenting a water-soaked appearance. On the third day after inoculation, the middle third commenced to soften and on the fourth day, the lower third began to do the same. The pieces gradually collapsed and a dirty white skin formed on the surface.

Horse Radish. Softening of the tissue, even of the hardest and most woody parts, to a depth of 2 - 4 m.m. occurred in 48 hours. There was a whitish growth on the surface, gas bubbles formed, and the centre of the stem fell in. The odor on the third day was quite pronounced and very objectionable.

Rhubarb. The organism grew on the cut surface of rhubarb only when the petiole was well saturated with water. There was a whitish growth on the surface, and softening, especially of the tissues between the bundles. Long, slimy threads, a foot or more long, were drawn out by touching the affected portion with the platinum needle.

Onion. On the slices of onion, strongly acid to litmus, there was considerable growth in 24 hours. The tissue was softened and the parts affected were slightly yellow in color. In three days the growth was quite yellow, a few gas bubbles were seen on the surface, the tissues were completely softened and there was a foul, nauseating odor.

Twelve onions, of three different varieties, were inoculated; but all rotted in the manner above described.

Morphology. The bacillus varies considerably in length. From agar culture grown at 20°C. for 24 hours the bacilli vary from 1.3μ in length, the average is about 2μ , the width 0.6μ . In old (3 month) agar cultures the bacteria are shorter. In gelatine (3 days at 20°C.) the average length is 1.4μ width $.5\mu$. In beef bouillon (48 hours at 25°C.) the average length is 1.2μ and the average breadth $.7\mu$. In wort (12.2 Ball.) the bacilli are longer, averaging 4μ long and 1μ wide. The longer rods are frequently bent and will stain deeper at the poles than at the middle.

On rhubarb the bacilli are short and plump and many are ovoid in shape. They are about 1.1μ long 0.8μ wide.

In sections of diseased cabbage and cauliflower the bacilli vary greatly in length, averaging about 2μ long and 0.6μ wide.

The ends of the bacillus are always rounded, occasionally bent rods may be seen and short chains may form; but usually the bacillus occurs singly.

Flagella. The bacilli taken from agar cultures 24 hours old are very motile, as are also bacilli from other media, (wort, gelatine, cauliflower). The linear progression is fast and the rotary motion of the cell is quite noticeable, the rear end of the motile rod moving in a larger circle than the front.

The bacillus has peritrichous flagella, seven to thirteen in number, which stain well by Van Ermegen's method. (See Fig. 11).

Spores. No spores have been observed. *Involution forms* are found. Thus the bacteria may be ovoid, or long and bent, occasionally club-shaped individuals are seen.

Stains. The bacillus from gelatine culture stains well with gentian violet, not so well taken from agar. Carbolfuchsin gives good results, for cover glass preparations and also for sections of diseased tissues. It stains slowly with methelene blue. In three minutes the bacilli are only very faintly colored.

It does not accept Gram's Stain.

CULTURAL CHARACTERS.

Bouillon at 28° C. In 24 hours the culture was very turbid, no pellicle and heavy sediment. In 48 hours the turbidity increased. The sediment was heavier and flocculent masses were deposited on the sides of the tube. A ring formed at the surface. In three days a pellicle formed which settled on slight disturbances. In six days the pellicle and ring on undisturbed tubes were heavier.

Media remained turbid (4 weeks).

In cabbage bouillon with 1 per cent. of peptone the organism grew very well, and produced heavy turbidity and copious sediment in 24 hours, a slight ring formed at the surface on the fifth day, otherwise there was no change.

Gelatine. On plate cultures of nutrient gelatine the colonies were visible to the naked eye in 24 hours. They were punctiform and round. With $\frac{2}{3}$ objective they appeared round, homogenous, with weak refraction and entire edges. In 48 hours the surface colonies were 2 m.m. in diameter, liquefying, round, greyish white in color and with a ring in the centre composed of deposited bacilli. Under the microscope ($\frac{2}{3}$ obj.) they were round, coarsely granular, the centre was grumose, and the edges slightly ciliate. Deep colonies were considerably smaller, less than 1 m.m. in diameter, round, internal structure moruloid, edges of some colonies were entire, others with effused growth. There was considerable variation.

In three days the surface colonies were from 3-5 m.m. in diameter round, greyish color, liquefaction shallow, often with one or two concentric rings. Under the microscope the edges appeared ciliate, the centre moruloid, and the rest of the colony granular. The bacterial masses might be seen in motion.

The deep colonies were smaller with darker centre and ciliate edge, the fringe being longer and more wavy and interwoven than in the surface colonies.

In 4 days the colonies were larger in size otherwise there was no change.

In stich cultures at 20° C. there was a white growth along the line of puncture in 24 hours. Slight liquefaction at the surface, $\frac{1}{2}$ m.m. in diameter, along the line of inoculation the growth was slightly heavier. In 4 days the liquefied area reached the sides of the test tube and thereafter liquefaction was stratiform.

There was often considerable difference in the rate of liquefaction, at times the whole tube might become liquefied, at other times only the half.

Wort gelatine. Stich cultures. The organism grew very well in this medium, with shallow pit liquefaction, followed by stratiform liquefaction to a depth of 5 m.m. in 7 days (20° C.) Growth stopped when about half the medium was liquefied.

Whey gelatine stich cultures. There was a crateriform depression 12 m.m. in diameter, with deposition of a flocculent mass in the centre of the pit in 24 hours. In 48 hours liquefaction had extended to the sides of the tubes and downwards to a depth of 2 m.m. at the sides and 3 m.m. in the centre. In three days the liquefied portion was 5 m.m. deep and growth ceased when 9 m.m. deep. A few gas bubbles appeared in the gelatine at some distance from the line of puncture

Agar. On agar plates at 28° C. colonies were not characteristic. Surface colonies spread very fast, as thin grey expansions, which varied greatly in shape. Deep colonies were dense, punctiform, round, or elliptical; in fact, there seemed every variety of shape. Agar slope cultures at 28° grew very rapidly over the surface as a moist, thin, whitish growth, slightly opalescent by transmitted light. There was considerable deposit of the bacilli in the condensation water. The growth became more massive with age, otherwise there was no change.

Carbo-hydrate agars. Slope and shake cultures were made in agars containing 2% of the following carbo-hydrates: Glycerine, saccharose, lactose, glucose, and maltose. The media was made from Liebig's Extract of Meat, reaction neutral. Check cultures were made in agar without carbohydrates, no gas formed in these.

In glycerine agar the growth was more abundant and whiter than on plain agar. No gas in the shake culture and heaviest growth on the surface.

In saccharose agar amount of growth exceeded that on plain agar. In shake culture a few gas bubbles were present.

In lactose agar the growth exceeded that on plain and glucose agar and was more waxy looking. In shake cultures there were numerous lenticular gas bubbles. In 48 hours there was an increase in the number of gas bubbles, and the agar was rent across the tube. In three days the clear space between the rents was wider, otherwise no change.

In glucose agar the growth was about the same as on plain agar, if anything, slightly heavier. Shake cultures contained small gas bubbles all through agar. No further change after three days growth.

In maltose agar growth was very abundant, moist and shiny. There was more tendency to spread. Growth exceeded that on plain agar.

In shake cultures very few gas bubbles appeared in 24 hours. In 48 hours, a few more bubbles made their appearance and no further change took place after the third day.

Neutral red agar (with 2 per cent. glucose at 28° C.) In 24 hours, there was no change in color, a white growth along the line of puncture and a moist white growth on the surface. A few gas bubbles were present. In 48 hours, there was no change in color but more growth. On the sixth day, the color was lilac violet and no further change occurred. (20 days.)

Milk. A number of milk tubes + 1.5 per cent., inoculated with 1 oese of a fresh bouillon culture and held at 25° C shewed no change for 24 hours. In two days the milk was thicker but did not coagulate until the third day. The curd was soft and even, but thicker at the bottom of the tube. On the fourth day, the curd shrunk and on shaking, the whey separated out. The curd was flaky with a few gas bubbles in it. On the fifth day, the whey on the surface was clear and remained so. In eight days, the curd shrunk and occupied one-third the depth of the medium. No further change took place. The whey from milk cultures tested for proteolytic enzymes, by means of the caustic potash and copper sulphate test, gave a violet color indicating the presence of peptones. Another portion of whey was mixed with ammonium sulphate to precipitate the proteids, and the filtrate from this precipitate was also tested in the same way, and with the same results.

The odour of milk cultures after heating was agreeable, resembling cheese curd. No odour could be noticed in the cold cultures.

The viability of the organism in milk was as follows : Cultures, 25 days old, living; 35 days old, living; two months old, dead.

Litmus Milk at 25° C. In 24 hours the color compared with the control tubes was appreciably different. In 48 hours, the color was lighter, between lilac and livid (Saccardo 48 and 49), the milk was thick but not coagulated. In three days, the milk coagulated into a soft even curd with about 10 m. m. of whey on the surface and a few gas bubbles in the coagulum. Colour lilac (Saccardo 48). In four days, the curd had shrunk leaving a clear whey on the surface. The curd when shaken separated into flaky masses and gas bubbles were fairly numerous through the curd on the surface. The color of the curd at the bottom of the tube was white, the upper portion, lilac. On the fifth day, the whey was slightly tinged with color; the lower half of the curd was white and the upper half, lilac. On the eighth day, there was only a small red ring of color at the top of the curd. On the twelfth day, the lilac color again returned.

Blood Serum at 25° C. On blood serum good growth occurred,—first, as a moist slightly spreading growth, later becoming heavier, more opaque and opalescent by transmitted light. The condensation water was turbid. Slight liquefaction was visible on the 8th day, and in 21 days most of the sloped surface became liquid and no further change occurred. The bacilli from blood serum shewed banded and bipolar staining with carbol-fuchsin.

Egg Media. (Dorset's method). Good growth occurred on egg media, spreading over the entire surface. No liquefaction occurred in 24 days and the growth was not characteristic.

Dunham's Solution at 25° C. In Dunham's solution there was slight growth; and uniform turbidity in 24 hours, the cloudiness increased and a slight sediment formed which became flocculent in four days. Eight-day cultures gave a very slight indol re-action, while in 15-day cultures the re-action was more marked.

In Dunham's solution with Rosolic acid (in the same proportion as used by Jones), the salmon pink colour almost entirely faded in 24 hours. In 48 hours, the tubes were quite decolorised and remained so three months. Rosolic acid bouillon was decolorised in the same way. This change shewed the formation of acid.

Synthetic Media. In Uschinsky's medium there was turbidity with some sediment in 24 hours at 25°C. A slight pellicle formed in 48 hours, and the body of the media became more turbid with increase

of sediment. In seven days there was a thick pellicle and heavy sediment, but the body of the liquid was almost clear. In 15 days the pellicle gradually sank, the body of the liquid was pale yellow, and there was a copious sediment.

In Fermi's medium, there was slight turbidity in the upper third of the medium and a very slight sediment in 24 hours at 25°C. A thin pellicle formed in 48 hours and the top of the liquid was very cloudy. On shaking, the pellicle produced turbidity throughout the entire medium. The growth at four, seven and fifteen days resembled growth in Uschinsky's medium.

In *Lager Beer Wort*, 12.2 Ball. good growth occurred, at first turbid and with considerable sediment. The liquid was several shades lighter in color, and a few gas bubbles were seen. In three days, the wort was quite clear, with heavy fine sediment and no pellicle. No further change occurred.

Cooked Vegetables. Generally speaking, the growth on cooked vegetables was abundant, but the softening action of the organism on the cooked vegetables was not always as marked as its action on raw vegetables; in other words the production of cystase was more marked when the organism was placed upon slices of raw vegetables.

Potato prepared according to Roux's method, reaction slightly acid to litmus. In 24 hours there was a moist, shiny, spreading growth distinguishable from the potato by the glistening appearance. The growth became more massive and on the drier slices the growth was more waxy looking and straw colored. No further change occurred and the potato slice was slightly softened, it could never be cut quite through with the platinum needle.

On potato cylinders prepared by immersing half the slice in water, the growth was moist and spreading. The water was at first turbid with much sediment, consisting of particles of softened potato, pure white in colour. In seven days the liquid became yellow in colour and the sediment was pure white. Gas bubbles were also present.

The immersed portion of the cylinder was softened, but in twenty days the core above the water was still firm and could not be cut with the platinum wire, a control test on raw potatoes from the same source caused complete softening of the tissues in three days.

In other tests of potatoes there were minor differences—Thus the growth would be dirty yellow, or honey yellow in colour, and the

moist and glistening appearance on some potatoes would be changed to a dull waxy looking growth.

Differences in the rate and extent of softening also occurred. In all some 60 tests were made on potatoes.

On cooked carrot at 28°C, there was a moist spreading growth with complete softening in three days.

On cooked sugar beet there was a flat, shiny, moist growth; gas bubbles were present, and the cylinder was completely softened in four days.

On cooked beet-root there was a whitish spreading growth, the beet was discoloured (brown-green), and there was a white, slightly raised moist growth, with complete softening.

On cooked onion there was a moist, dirty white growth, the onion was completely softened and fell to pieces. The odor was foul and nauseating.

Temperature relations. The optimum was about 30° C.; there was fast growth at 25° to 28°. Good growth occurred at 20° and at 37.5° C. the growth was better than at 20° C.

The maximum temperature was in the neighborhood of 42° C.

The minimum temperature was in the neighborhood of 5° C.

Thermal death point. The thermal death point was determined by Sternberg's method. The temperature of the bath during the time of exposure was varied about .25 of a degree. A temperature of 55° C. for 10 minutes was the thermal death point of the organism.

Relation to free oxygen. The aerobic growth was better than the anaerobic, but the organism grew in the closed arm of fermentation tubes, and in deep stich cultures.

Agar, potato, gelatine slope and litmus milk cultures were grown for eight days in a Novy jar in an atmosphere of hydrogen.

There was slight growth limited to the needle track on the agar slope; slight growth but no liquefaction of the gelatine slope culture; very slight growth on the potato; slight growth and change of colour in milk, but no coagulation. The cultures when taken out of the Novy jar grew vigorously. The bacilli from the agar culture were rather shorter, averaging about 1.5 μ , in length.

Nitrate broth at 25° C. In nitrate broth growth was better than in Dunham's solution. The media becomes turbid with first a fine and later a flocculent sediment. No pellicle formed.

The tests for nitrites on the 9th day were negative, on the fifteenth day there was a faint pink tinge with the naphthylamine and sulphanilic acid test. Control tubes kept under the same conditions gave no indication of nitrites.

Indol production. See Dunham's solution.

Development of odors. The strongest and most offensive odor developed on onions, both raw and cooked. There were objectionable odors from cultures on cabbage, cauliflower, horse radish, rape and turnips.

The odor on white carrot was pungent. Milk cultures when heated give an odor of fresh curd.

Production of hydrogen sulphide. Strips of filter paper moistened with lead acetate were suspended over bouillon and potato cultures. In both cases the paper turned black indicating the production of hydrogen sulphide.

Production of acid. Acid was produced in all sugar media, in milk, in Dunham's solution, and in bouillon.

Production of alkali. Ammonia was produced in potato cultures in considerable amount, it could be detected by the smell, as well as more exactly by Nessler's reagent. Cultures on several other vegetables (turnips, carrots, beets) also gave the Nessler reaction.

Relation of growth to acid and alkali. Various quantities of normal sodium hydrate and normal hydrochloric acid were added to neutral broth. The following results were from 48-hour old cultures kept at 28° C.

Neutral broth. Turbid and considerable sediment.

Alkaline broth + 10 c.c. of normal NaOH per litre: Same as neutral tubes

"	"	"	"	"	"	"
"	"	20	"	"	"	"
"	"	30	"	"	Turbid and slight sediment.	
"	"	40	"	"	Very slight turbidity.	
"	"	50	"	"	Quite clear, no growth.	

Acid broth + 10 c.c. of normal HCl per litre: Turbidity greater than in control.

"	"	20	"	"	Same as neutral tubes.	
"	"	30	"	"	Slight turbidity.	
"	"	40	"	"	" "	
"	"	50	"	"	Very slight growth.	

Effect of sunlight. Cover glass preparation made from 24-hour old bouillon culture and exposed to direct sunlight gave the following results:—

15 minutes	$\left\{ \begin{array}{l} + \\ + \end{array} \right.$	.....	30 minutes	$\left\{ \begin{array}{l} + \\ + \end{array} \right.$
45 "	$\left\{ \begin{array}{l} + \\ + \end{array} \right.$	.....	1 hour	$\left\{ \begin{array}{l} + \\ - \end{array} \right.$
1.15 hours	$\left\{ \begin{array}{l} + \\ - \end{array} \right.$	.....	1.30 hours	$\left\{ \begin{array}{l} - \\ - \end{array} \right.$
1.45 "	$\left\{ \begin{array}{l} - \\ - \end{array} \right.$	.....	2 "	$\left\{ \begin{array}{l} - \\ + \end{array} \right.$

$\frac{+}{-}$ Living on some cover glasses but dead on others; + living; — dead.

Agar plates inoculated with 1 oese of a fresh bouillon culture and exposed to direct sunlight gave the following results:

Control plates not exposed 1,200-2,000 colonies per plate.

Plates exposed 15 minutes				{ centre, 2-5 colonies per plate.			
				{ edge, 220-400 " "			
"	"	30	"	{ centre, 0-10 " "			
				{ edge, 130-200 " "			
"	"	45	"	{ centre, 0-1 " "			
				{ edge, 10-60 " "			
"	"	1 hour		{ centre, 0 " "			
				{ edge, 10-60 " "			
"	"	1.30 hours		0	"	"	"
"	"	2 "		0	"	"	"

The plates were exposed in the afternoon between 2 and 4 p.m. in the month of October. Temperature of the plates, 30° C. Latitude, 43°, 30."

Resistance of the organism to desiccation. For determining the resistance to dessication cover glass preparations were made from a 24-hour old bouillon culture and exposed to the light in a room for various periods of time. Under these conditions the bacillus was killed after two days exposure.

Growth in Fermentation Tubes. The foundation medium was composed of 1 per cent. peptone, .25 per cent. Nahrstoff Heyden, and 5 per cent. salt, with the reaction carefully neutralised to phenolphtha-

lein, 2 per cent, of the following sugars, saccharose, lactose, glucose was added to the above medium, and the tubes sterilized at 100° C. on three successive days.

Saccharose bouillon. Both arms of the tube became cloudy, considerable sediment formed but no pellicle. Reaction after 10 day's growth + 1.8 per cent.

Lactose bouillon. After 24 hours both arms of the tube became cloudy, the closed one with less turbidity, there was some sediment but no pellicle or gas. After 48 hours, the amount of sediment increased and 1 per cent. of gas formed, subsequently the closed arm became clear, but there was no increase of gas. Reaction after 10 day's growth, + 1.43 per cent.

Glucose bouillon. There was more growth in this medium than in the others, 0.5 per cent. of gas collected on the 2nd day, with no subsequent increase. Sediment very copious. Reaction after 10 day's growth, + 1.8 per cent.

Enzymes. Proteolytic enzymes, cytase, and diastase are produced by the organism. Evidence as to the formation of these enzymes is afforded by the following experiments.

Proteolytic Enzymes. These enzymes are produced in small quantities. Gelatin is slowly liquefied, blood serum even more slowly, milk is partially peptonized.

Fresh milk serum sterilized by filtration was inoculated with a culture of the bacillus, and the medium held at 25 degrees C., for 10 days. At the end of this time a portion tested for peptones gave the biuret reaction. The proteid bodies except peptones in the larger portions were precipitated with ammonium sulphate and the filtrate treated with caustic potash solution and copper sulphate gave a violet color indicating the presence of peptones.

Diastase. Diastase is produced in small quantities in ordinary bouillon. Equal parts of sugar free starch paste and thymol were mixed with a 10-days old bouillon culture and left at 25 degree C., for 12-24 hours. A test of the filtrate of this mixture with Fehling's solution showed small traces of sugar to be present.

The organism when grown on potato also destroyed starch. Slices of raw potato inoculated with the organism did not give any coloration when treated with iodine, which indicated the destruction of the starch.

Cytase. The greatest interest in this organism is its power of destroying the cell walls of various plants. The quick spreading nature of the rot shows that the cell-wall-destroying-enzyme must be elaborated in considerable amounts.

This enzyme was isolated in the following manner:—

Sound potatoes were peeled and pieces cut out of the centre with sterilized knives. These pieces were scorched over the naked flame of a Bunsen burner and then dropped into wide mouth sterilized flasks containing 50-200 c. c. of sterilized distilled water.

This operation, although carefully carried out in a chamber washed with corrosive sublimate, was not always successful as a number of the flasks became contaminated with foreign organism: however, some flasks were obtained which contained nothing but *B. oleraceae*, and these, after incubation at 25 degree C. for 10 days, were emptied into a fine sterilized cloth and the juice pressed out.

This juice was then filtered through absorbent cotton and treated with four times its bulk of 94 per cent. alcohol, which gave a fine cloudy precipitate. The mixture was frequently shaken and was left at room temperature for 24 hours. After the final shaking the precipitate was allowed to sediment for 12 hours when the supernatant liquid was siphoned off, and the sediment collected on a hard filter paper, washed with alcohol, dried and then a hole was made in the filter and the precipitate washed off into a sterile flask with sterilized distilled water. This solution was then forced through a Pasteur-Chamberland filter, collected in a sterile flask and 5 c. c. portions of the liquid filled into sterilized test tubes. The liquid was clear with a yellowish tinge and was quite sterile. (Incubation of tubes at 25° C.)

Twenty test tubes were thus obtained and 8 of them were treated as follows:—

4 were heated to a temperature of 65 degrees C. for 10 minutes.

4 were heated to a temperature of 212 degrees C. and then cooled.

Small slices of potato and white turnip were then cut with sterile knives and introduced into the tubes which were placed in a thermostat at 20 degrees C. At the end of 24-36 hours the tubes were carefully examined and those that showed bacterial contamination were put aside. The small pieces of tissue were fished out with a sterile spatula and placed on a slide, a cover glass placed on top and the preparation examined under microscope. The sections of turnips and potato in the boiled and heated tubes were unchanged, they were

firm, the cell walls unaltered with sharp outlines, and about $2\ 3\text{--}5\mu$ in width. The tissues in the unheated tubes were very soft, much swollen, and in some cases quite disintegrated. The cell walls were much enlarged, some striated and from $5\ 8\mu$ in thickness.

This experiment shows that *B. oleraceae*, secretes a cytase which has a very powerful action on the cell wall and particularly on the middle lamella, and that this enzyme is killed by a temperature of 65 degrees C. for 10 minutes.

CONDITIONS AFFECTING THE SPREAD OF THE DISEASE.

1. *Metereological Conditions.* The weather of July, August, and part of September was very favourable for the growth and spread of both fungus and bacterial diseases. In Ontario, the rust on cereal crops was very bad. Many newspapers spoke of the grain "being blasted in a single night."

The Toronto Metereological Register shows that July and August, 1901, were warmer and rather moister than the average; in the month of August when the cauliflower diseases was noticed, the average humidity was 86, and the rainfall 3.67 inches. The temperature also was high. Very many mornings in July and August, the dew was so heavy that, in spite of great heat and cloudless sky, one could get quite wet when walking through the rows of cauliflowers in the afternoon. An examination of these plants in the field showed that the base of the plant, or the juncture of the petioles of the leaves with the stem, contained considerable water and in most cases particles of soil and if the organism exists in the soil, which is probably the case, it would be in a favourable situation to cause infection.

The warm weather, combined with excessive moisture, both of the soil and the exterior of the plant, and the fact that transpiration would be checked by this condition, and consequently the plant-cells themselves would be full of sap, undoubtedly played an important part in the spread of the rot amongst the cauliflowers and turnips. In short, we can state that the atmospheric conditions were ideal for vigorous bacterial growth, and that these metereological conditions have considerable influence on the ease with which the bacillus penetrates the plant.

2. *Rankness of Growth.* The weather conditions above mentioned, and the plentiful use of manure by market gardeners, favor very quick, rank growth. The plants most affected were large, heavy, and

with many leaves shading the surrounding soil, thus conserving moisture and promoting quick growth.

3. *Abundance of Insect Pests.* The disease is chiefly spread by means of infection from wounds, and under field conditions these are usually produced by insects, especially the cabbage worm (*Pieris brassicae*) which was very numerous upon cabbage and cauliflower leaves. A careful examination of over 100 plants showed that one or more larvae were present on each plant. Slugs also do considerable damage to these plants, and obviously smear themselves with a number of soil organisms, and as I have already mentioned, the *Bacillus oleraceae* is probably a soil organism.

Ants and other insects swarm around turnips, eating the rotted pulp, and no doubt serve to carry the germs to other plants.

4. *Injury from Planting, Cultivation or Wind.* Leaves of turnips are frequently bruised or injured during cultivation, by either hand or horse hoes. Cauliflowers may be injured during planting out, and the infecting organism brought into contact with the broken surface. In cases of very rank growth, a heavy wind may cause leaves to be broken off, and thus afford bacteria a chance to penetrate into the plant tissues. Many gardeners trim their cauliflowers on the field, and when these are infected they carry the disease on to another season. The same ground is often used year after year for the same crops, a dangerous procedure when disease is present, as it is likely to make the trouble endemic.

5. *Susceptibility of Varieties.* According to the limitations placed upon the meaning of "resistance" and "immunity" in plants by Russell, we shall define resistance as the "inherent power of the vegetable organism to withstand the action of bacteria in general;" and immunity as "the ability of the organism to repel the attacks of a germ which produces a pathological condition in a closely allied form."

We find that white turnips and cauliflowers are very susceptible to inoculations of *Bacillus oleraceae*, whether carried out in the laboratory, or met with under field conditions. Our laboratory experiments were all carried out on the Greystone variety of white turnips, which, under field conditions, seems to have some immunity; but which readily succumbs to artificial inoculations. We have kept careful record of the amount of disease present among the different varieties tested on our trial grounds.

Bacteriological examination of the disease present in the different varieties showed that we were working with the same bacterial disease. The amount of disease present is shown in the following list of varieties :—

Immune : Jersey Navel.

Less than 5 per cent. Rotted : Greystone Improved, Purple Top Mammoth, Early American Purple Top, Red Top Strap Leaf, White Flat Dutch Strap Leaf, White Egg, White Lily, Warly La Crosse, Red Top White Globe, Rennie's Selected White Globe, White Top Strap Leaf, Hunter's Purple Top Globe.

Between 5 and 15 per cent. Rotted : White Stone, Cow Horn, Yellow Stone, Green Barrel, Lutton's Imperial Green Globe, White Six Weeks, Milk Globe, Orange Sweet, Long Tankard, Sutton's Favorite P. T. Yellow Hybrid, Sutton's Perfection Green Top Hybrid, Yellow Finland, Large White Norfolk, Sutton's Purple Top Scotch.

Between 15 and 30 per cent. Rotted : Early Purple Top Murrich, Pomeranian White Globe, Red Globe Norfolk, Purple Top Hybrid, Jersey Lily, Early White Model, Extra Early Milan.

Between 30 and 50 per cent. Rotted : Orange Jelly, Imperial Green Globe, All Gold, Yellow Globe.

Between 50 and 65 per cent. Rotted : Yellow Aberdeen Green Top, Yellow Aberdeen Purple Top.



Fig. 1. A healthy cauliflower plant; uninoculated and grown under the same conditions as the inoculated plants.



Fig. 2. Cauliflower plant inoculated from a pure culture of *B. oleraceae* by means of a single needle prick at the base of the petiole. At the end of six days. Note the fallen leaf, wilted appearance of the leaves on the left side and the blackened stem above the fallen leaf.



Fig. 3. Cauliflower plant inoculated from a pure culture of *B. oleraceae* by means of a single needle prick at the base of a petiole. Shows the rotting of the flower. Ten days from inoculation.



Fig. 4. Cauliflower plant inoculated by placing a piece of softened tissue, taken from the interior of an affected inoculated petiole, on the surface of the healthy flower. The flower is reduced to a pulpy, black mass. Five days from time of inoculation.

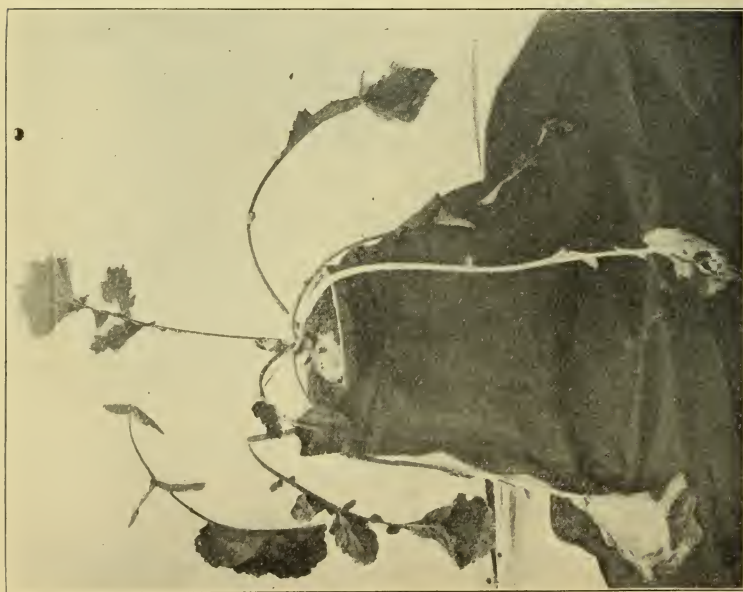


Fig. 5. A white turnip plant inoculated at the crown from a pure culture of *B. oleraceae* by means of two needle punctures. The photograph shows the plant nine days after inoculation.

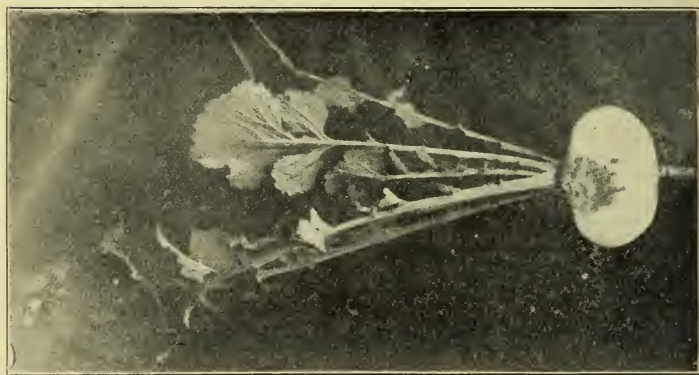


Fig. 6. A turnip plant cut in half in order to show the extent of the rotting process, six days after inoculation with *B. oleraceae* by one needle puncture.

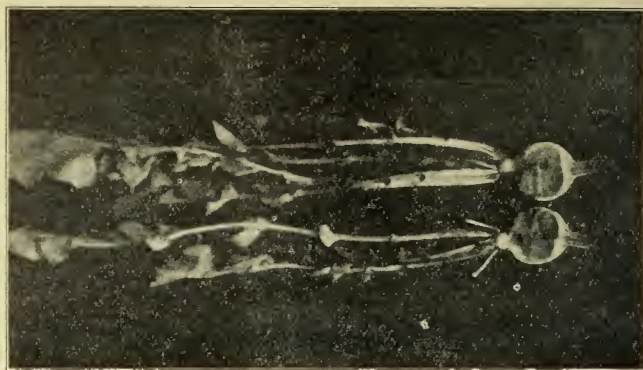


Fig. 7. A turnip plant cut in two in order to show the almost complete rotting. Ten days after inoculation with *B. oleraceae*, one needle puncture at the crown.



Fig. 8. The edible portion of a cauliflower cut in two with a sterilized knife and inoculated with a pure culture of *B. oleraceae* by means of a single needle prick in the centre of the flower. Note the blackened portion which was softened to a considerable depth and also the water drops upon the blackened area.

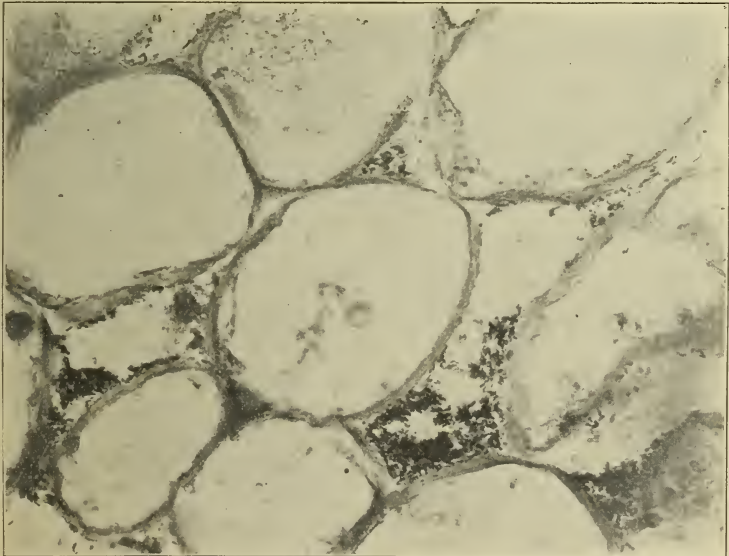


Fig. 9. Cross section of part of the petiole of a diseased cauliflower inoculated with a pure culture of *B. oleraceae*. Note the bacteria in the intercellular spaces and their penetration along the middle lamella.

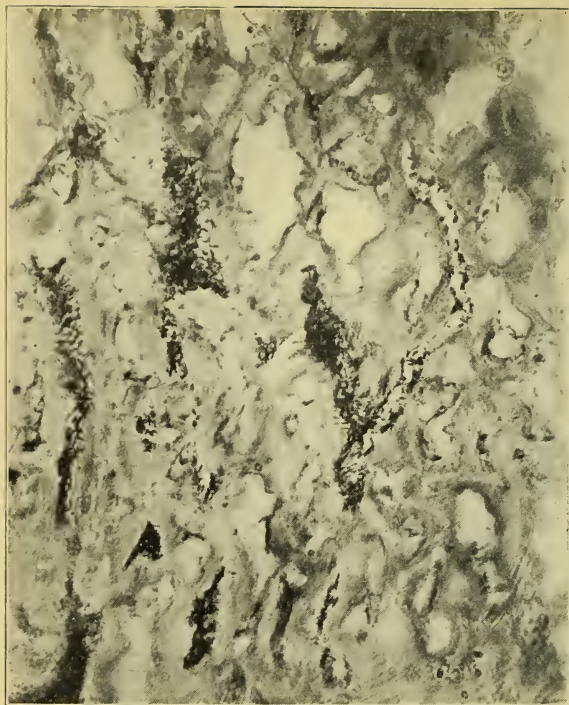


Fig. 10. Cross section of the petiole of a cauliflower plant inoculated with a pure culture of *B. oleraceae*. At a later stage than Fig. 9, showing the almost complete collapse of the tissues, the enlarging and softening of the cell walls and the great increase in the number of bacteria.

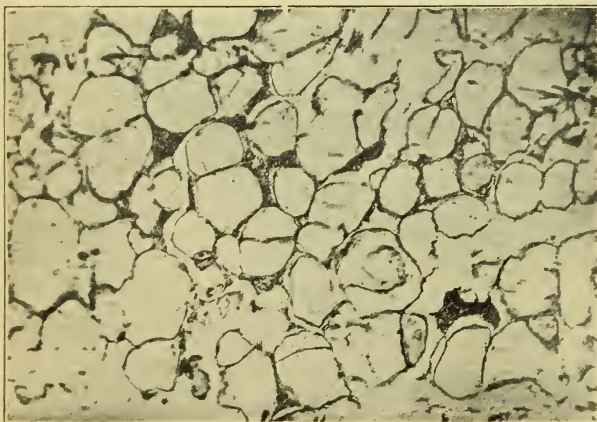


Fig. 11. Cross section of a piece of turnip. This was taken from a plant inoculated with a pure culture of *B. oleraceae*. Note the disorganization of the cells and the large numbers of bacteria in the intercellular spaces.

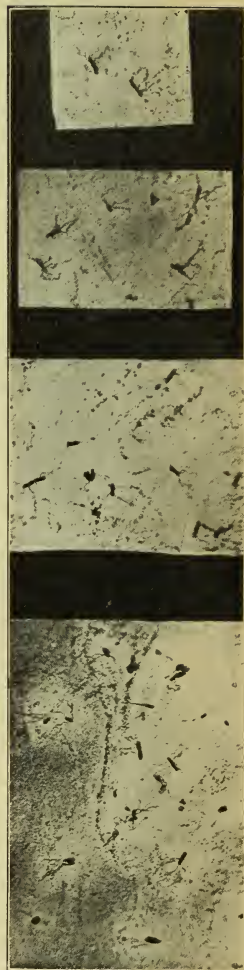


Fig. 12. *B. oleraceae*. The flagella stained by Van Ermegen's method. The bacteria were taken from an agar culture 18 hours old.

Ontario Agricultural College and Experimental Farm

THE COMPOSITION OF ONTARIO FEEDING--STUFFS.

By W. P. GAMBLE, B.S.A., Lecturer in Chemistry.

The animal body is made up mainly of four classes of substances—water, ash or mineral matter, nitrogenous matter, and fat. The proportions in which these four classes of substances occur depend mainly upon the age of the animal, its treatment, and the purpose for which it is kept. The components of the body are continually breaking down and being consumed. To keep the animal in a healthy condition there must be a constant supply of new material. If this is lacking or insufficient, hunger and finally death result. To keep up this supply is one of the chief uses of food, but in addition to this, the food supplies the heat of the body, and at the same time furnishes energy, which enables the animal to move the muscles and do work external and internal. Furthermore, foods also supply immature animal with material wherewith to build up the tissues of the body.

It will, therefore, be seen that to supply food in the right proportion to meet the requirements of the animal, without a waste of food nutrients, constitutes scientific feeding, and it is by carefully studying the composition of feeding-stuffs and the requirements of animals that a great deal of information may be obtained which will be of inestimable value to the practical agriculturist.

Realizing the importance of such study, the author of this bulletin wrote to all the proprietors of flour, oat, pea, and starch mills in the Province, requesting them to send us samples of their by-products. Besides the samples obtained in this way we collected a large number of similar by-products from other sources. These feeding-stuffs were carefully analysed, and the tabulated results will appear in their proper places.

Before we examine the results of our analyses, however, let us understand the meaning of the terms used by chemists to designate the various components of a fodder.

(1). Protein (nitrogenous material) is the name commonly given to a class of substances which furnish the materials for the building up of lean flesh, blood, skin, muscles, brain, nerve, hair, horn, wool, etc., and for these purposes protein is absolutely essential in the food of animals. The animal cannot grow, nor can it long exist without constantly renewed supplies of protein in its food. Moreover the animal is totally unable to create protein. It is true that animals can produce blood protein, brain protein, flesh protein, and milk protein, but only by appropriating and transforming the protein of plants. Protein in some form is an essential constituent of all food.

(2). Fat (or ether extract) is the portion of the food which is dissolved from the water-free substance by ether, benzine, gasoline, etc. It is a very important component of feeding-stuffs on account of its high value for the production of fat, energy, and heat.

(3). Crude fibre is a term applied to a group of substances that are of limited value to the feeder, because not only are they largely indigestible, but what is still more important, they often render the rest of the food less digestible by protecting it from the action of digestive fluids.

(4). Ash is an inorganic portion of feeding-stuffs. Some of the foods richest in protein are also rich in ash material, and are, therefore, of high manurial value. The ash is also of great importance in the food of young and growing animals, as it furnishes the constituents from which the bone is built up.

(5). Soluble carbohydrates (or nitrogen-free-extract) is that portion of the food which is dissolved by boiling it with dilute acids and alkalies. It consists mainly of starches and sugars. When taken into the system nitrogen-free-extract forms fat or is oxidized to produce heat and energy.

(6). Moisture. However dry a feeding-stuff may appear, it always contains a considerable amount of moisture which can be driven out by heat. A high water content in a concentrated feeding-stuff is a decided detriment: first, because it diminishes the percentage of actual food material, and, second, because it causes the food to mould or turn sour sooner than if less moisture were present.

In addition to the chemical analysis, the samples that we collected were subjected to careful microscopic examination, so far as time permitted. The chemical analysis alone gives valuable information as to the total quantities of important food materials contained in the feeding-stuff. But as will be noticed in the following tables, certain by-products vary considerably in composition, according to the character of the season, methods of manufacture, etc., and unless they are decidedly abnormal in composition, it is impossible to say with any certainty whether they have been adulterated or not. Since, however, foreign material can be readily shown under the microscope, the combined chemical and microscopic examination is almost certain to detect any adulteration. It is gratifying to know, on account of the importance and wide use made of these materials, that the quality of the samples in most cases examined has been found to be quite up to the average. The only adulterants we were able to detect were particles of flour, whole wheat screenings, and oat bran, which under the conditions of manufacture might be expected to be present.

The tables which we are about to examine show how great are the differences in composition between different kinds of feeding-stuffs. Take, for example, the percentage of protein in cotton seed meal and compare it with that in corn bran, or even with that of some of the oat

feeds. The cotton seed meal, as will be shown, is a very concentrated food, while the amount of protein in corn, bran, and such substances is very low. Protein is the most expensive component of a feeding stuff and as has been stated, a considerable amount of it is absolutely indispensable to growth.

Hay, ensilage, corn, and roots, raised on the farm form the basis, and make up the bulk of the food for live stock, and supply all the starch, sugars, and fat required. They are, however, deficient in digestible protein, and if the quantity of digestible protein in a food is too small the animals produce less beef or milk than they would with a proper supply of protein. Furthermore, when protein is deficient the other food components (starch, fat, etc.) of the ration are in excess of the animal's capacity for assimilating them, and are, therefore, to some extent wasted. These, in part, pass out of the body, incompletely digested, and, unlike protein, give little value to the manure. In purchasing by-products or commercial feeds to supplement farm-grown crops, the keepers of live stock should bear in mind that the value of the food depends to a large extent on the quantity of digestible protein which it contains.

The tables referred to will aid in the selection of food of highest nutritive value. It must be remembered, however, that the tables give the total amounts of nutrients found by chemical analysis in the different feeding-stuffs, while only that portion of the food which is digested is of direct use to the animal.

The processes of digestion in the case of ruminant animals are carried on somewhat as follows: The food is taken into the mouth, where it is masticated and mixed with saliva, a secretion of the glands of the mouth. The saliva acts feebly upon the starch of the food converting portions of it to sugar. The masticated food then passes through the gullet, to the stomach, where it is subjected to the action of the gastric juice. From the stomach the undigested food passes through the pyloric orifice into the intestines, where it is further acted upon by the pancreatic secretion, and portions of the starch, protein, and other components of the food are dissolved or emulsified. The dissolved nutrients are absorbed from the alimentary canal, and, in the form of chyle, pass into the blood, and finally serve to nourish and sustain the body. This portion is said to be digested and assimilated, and from it alone the animal is nourished.

The digestibility of different foods, however, varies markedly; and, moreover, the digestibility of the same food varies under different conditions. But under average conditions the digestibility of the commoner foods has been roughly determined, and the practical feeder must make a study of such data before the figures giving the composition of different foods can be of much use to him. He should also investigate the whole question of digestibility in an independent manner, so as to be prepared to judge wisely in any given case.

We give the results of our analysis, with brief comment thereon:

Foods analyzed.	Crude Protein.	Moisture.	Ether Extract.	Crude Fibre.	Ash.	Soluble Carbo-hydrates.
<i>Pea Meal.</i>						
1. Pea meal from solid peas—	27.13	6.17	2.11	7.21	2.67	54.71
2. Dried pea meal obtained from splitting process....	26.87	8.69	2.45	3.21	2.20	56.58
3. Pea meal—W. Thompson...	16.97	9.95	1.24	6.86	2.61	62.37
4. Crushed peas—Thorp.....	27.12	10.23	2.01	7.23	3.70	49.71
5.—Pea meal—Tilson.....	22.50	11.57	1.53	6.82	2.33	55.25
6. Pea meal, 1902.....	20.29	12.64	2.71	8.43	3.01	52.92
7. Pea meal, 1903.....	25.16	11.79	1.93	6.51	2.87	51.74
8. Pea meal, 1903.....	20.11	11.65	1.21	10.09	3.26	53.68
Average.....	23.27	10.34	1.90	7.04	2.83	54.62
<i>Pea Hulls or Pea Bran.</i>						
1. Pea hulls.....	7.12	8.12	0.85	56.52	2.23	25.18
2. Tilson's pea bran.....	9.56	7.60	2.99	49.10	2.88	27.87
3. Thompson's pea bran.....	12.00	7.93	0.55	54.35	2.88	22.29
4. Ground pea bran—J. Wilson	15.66	7.35	3.54	25.25	3.08	45.12
5. Pea bran—Tilson & Co....	8.12	5.96	2.37	47.32	2.78	33.45
6. Pea bran—Murton.....	9.06	8.23	2.52	44.79	3.27	32.13
7. Pea bran, 1902.....	9.57	7.24	1.42	39.53	3.26	38.98
8. Pea bran, 1902.....	10.21	6.53	0.46	24.27	3.59	54.94
9. Pea bran, 1902.....	9.08	5.41	0.30	52.63	2.98	29.60
10. Pea bran, 1903.....	7.49	9.75	0.33	54.24	2.60	25.59
11. Pea bran, 1903.....	8.35	6.23	0.37	48.33	2.55	34.17
12. Pea bran, 1903.....	11.42	8.57	0.60	31.69	3.05	44.67
13. Pea bran, 1903.....	12.90	8.72	2.43	18.93	2.87	54.15
Average.....	10.04	7.51	1.44	42.07	2.92	36.01
<i>Mixed Chop.</i>						
1. Rye 1-5 Oats—R. Harvey.	12.71	13.48	5.95	4.44	5.39	58.03
2. Wheat ½ Oats—R. Harvey.	13.53	10.11	5.26	9.92	6.59	54.59
3. Rye, Oats, Wheat—Equal parts—R. Harvey.....	13.41	11.52	5.39	7.29	6.71	55.68
4. Oats, Wheat, Barley and Buckwheat—R. Harvey..	13.81	13.15	3.53	10.24	6.39	52.88
5. Grain Meal (Peas and Oats)	20.66	9.53	4.32	14.21	3.59	47.69
6. Mixed Chop (March 26, '03)	9.37	9.95	2.97	5.65	1.48	70.58
7. Farmel.....	9.75	8.50	4.10	9.98	3.35	64.32
8. Oats and Corn.....	8.50	12.56	2.95	18.71	2.01	55.27
9. Oat Chop, 1902.....	9.87	10.36	4.75	9.73	3.54	61.75
10. Oat Chop, 1902.....	10.24	9.27	5.32	8.72	3.27	63.13
11. Oat Chop, 1902.....	8.37	11.01	5.62	9.54	2.99	62.47
12. Oat Chop, 1902.....	14.79	10.39	4.96	10.36	3.21	56.29
13. Oat Chop, 1902.....	11.01	8.65	3.84	9.75	2.25	64.50
14. Oat Chop, 1903.....	12.87	13.42	5.30	9.31	2.64	56.46
15. Oat Chop, 1903.....	9.36	12.96	5.24	9.50	2.37	60.57
16. Peas and Oats, 1903.....	14.37	12.27	5.42	12.67	3.79	51.48
17. Peas and Oats, 1903.....	15.29	10.85	4.26	12.12	2.98	54.50
18. Peas and Oats, 1903.....	11.98	13.16	4.79	14.98	4.62	50.47
19. Peas and Oats, 1903.....	20.25	10.21	3.81	11.58	3.75	50.40
20. Peas, Oats, and Wheat, 1903	16.75	11.72	4.79	12.25	6.61	47.88
21. Peas, Oats, and Wheat, 1903	12.60	13.69	4.25	20.16	5.83	43.47
Average.....	12.81	11.27	4.61	11.00	3.96	56.35

PEA MEAL.

A glance at the foregoing table shows a variation of from 16.97 to 27.13 per cent. of protein. The average percentage of protein in the eight samples is 23.27, which is practically 3 per cent. above the average of four samples recorded by American authorities. The samples of pea meal forwarded by Mr. Thompson, of London, contained a very considerable amount of hulls. To this cause alone we attribute the low protein content of this sample. It is nevertheless possible that the fact that peas were badly damaged by the weevil may have had something to do with the low percentage of protein.

If we are to select food, taking protein as the standard, pea meal would stand very high on our list of concentrated feeding-stuffs. As peas are grown to a limited extent on many farms in our Province, such meal could scarcely be called a commercial feeding-stuff; nevertheless, we have included pea meal under this general heading, because there are certain sections in Ontario where peas are not grown to any extent, and in such localities feeders are dependent upon manufacturers or dealers for their supply of pea meal.

As will be seen in the above table of composition, pea meal would make an excellent food to supplement some of our home grown fodder. Besides showing a very high protein content, pea meal also contains a fair percentage of fat and soluble carbohydrates. The relative percentage of crude fibre is moderately low. Moreover, from digestion experiments carried on by this Station, we are led to believe that the crude fibre of pea meal is digested to a far greater extent than is the crude fibre of some of the by-products which will be noted later on.

PEA BRAN OR HULLS.

Thirteen samples of pea bran were analysed. With the exception of one sample, obtained from J. Wilson, the protein content varied from seven to thirteen per cent. The high protein content of Mr. Wilson's sample was, no doubt, due to the fact that it contained quantities of fine pea meal or dust. Such a sample of pea bran would make a very excellent supplement to our coarse cattle foods. The percentage of crude fibre in most cases is very high. I may state, however, that we fed three sheep for a period of one month on pea hulls alone. At the end of the experiment the sheep were weighed, and it was found that they weighed exactly the same as at the beginning of the feeding period. The digestibility of the different components of the pea hulls was at the same time tested, and the results obtained go to show that the digestion co-efficient of the crude fibre of the pea bran was 69; i. e., for every hundred pounds of crude fibre fed 69 pounds were digested. From these facts we are led to believe that the feeding value of pea bran is greater than the low protein content would indicate. It must not be gathered from this that we would recommend this food in preference to those richer in protein. On the contrary, farmers and dairymen should always aim at securing a fair quantity of protein in any food which is meant to supplement a ration of corn fodder, hay, ensilage, or other home grown feeds. Pea bran, however, is not entirely useless, and might, under certain conditions, serve as a useful component in a maintenance diet.

MIXED CHOP.

In the twenty-one samples of chop analysed the percentage of protein was found to vary between 8.37 and 20.66. The average protein content of these samples was 12.81 per cent. A glance at the table will show that what is ordinarily called chop may be a mixture of various grains grown on the farm. The mixture of oats and corn shows a low protein content when compared, for example, with peas and oats. The practical conclusion to be drawn from this fact is that the feeder should, other conditions being equal, select the richer of the two to supplement a ration made up largely of hay, ensilage, and roots, more especially if this ration be intended for dairy cows.

The above table of composition shows that chop is valuable food; and where the average farmer has an abundance of such food at his disposal it would be folly for him to purchase many of the by-products at present sold without any guarantee as to their composition. Furthermore, experiments conducted by Professor Day on fattening steers appear to indicate that a ration containing a rather wide nutritive ratio will give more economical gains than one possessing a relative narrow nutritive ratio. For fattening purposes, therefore, we believe that chop, such as mentioned in the foregoing table, would supply all the nitrogenous material necessary. If, however, the production of milk were the object, then it might be advisable to select a food containing a greater quantity of protein.

WHEAT MIDLINGS.

Upon inspecting the analyses of the samples of middlings, recorded in this Bulletin, the reader will be struck by the uniformly low percentage of moisture. The average percentage of moisture recorded by American chemists is approximately two per cent. higher than that found in the twenty one samples analysed in our laboratory. I may state that as soon as these samples arrived in our laboratory they were at once placed in bottles with ground glass stoppers to prevent any evaporation of moisture, and in every case extreme care was exercised in determining accurately the moisture content of the samples. The fact that any sample of food contains a low per centage of moisture is of great importance to the feeder, inasmuch as, other things being equal, he obtains a larger amount of nutritive material in a food containing a low percentage of moisture than he would if the moisture content were even one per cent. higher.

A few samples analysed showed an abnormally high percentage of crude fibre. A microscopic examination of these samples revealed the presence of considerable quantities of wheat bran. I may say that these samples were obtained on the market so that their source could not be traced. Samples Nos. 12 and 13 indicate almost as much crude fibre as is found in pure wheat bran, which rarely runs over ten per cent. In samples of pure wheat middlings, the percentage of crude fibre usually

Foods analyzed.	Crude protein.	Moisture.	Ether extract.	Crude fibre.	Ash.	Soluble carbo- hydrates.
<i>Wheat Middlings.</i>						
1. Thorp's Middlings.....	15.75	8.70	3.99	4.91	3.58	63.07
2. Middlings—Tillsonburg...	15.94	9.12	4.40	3.96	3.92	62.66
3. Middlings—Goldie Co., Ayr	16.26	10.28	3.26	3.70	3.65	62.85
4. Middlings—Frontenac Co..	17.66	8.29	4.10	3.91	4.25	61.79
5. Middlings	15.43	10.53	3.03	4.48	4.12	62.41
6. Middlings	13.79	9.70	2.71	4.28	3.86	65.66
7. Middlings	16.45	9.42	4.89	2.93	3.79	62.52
8. Middlings	16.62	10.52	4.25	3.25	3.85	61.51
9. Middlings	16.65	10.75	3.99	5.40	4.20	59.01
10. Middlings	15.46	11.21	3.65	2.72	4.00	62.96
11. Middlings	16.32	9.69	4.60	3.99	3.47	61.93
12. Middlings	12.73	9.73	2.99	8.62	3.61	62.32
13. Middlings	12.97	11.75	3.62	8.50	3.20	59.96
14. Middlings	13.47	10.62	3.75	3.78	3.12	65.26
15. Middlings	15.65	10.40	3.00	3.21	3.05	64.69
16. Middlings	17.10	8.62	4.11	2.50	4.04	63.63
17. Middlings	15.32	9.77	4.00	5.42	3.79	61.70
18. Middlings	17.25	10.02	3.65	5.00	4.21	59.87
19. Middlings	14.33	11.51	3.97	2.92	3.50	63.77
20. Middlings	17.12	12.05	5.52	2.45	3.20	59.66
21. Middlings	14.80	9.35	4.69	3.29	3.60	64.27
Average	15.54	10.10	3.92	4.26	3.72	62.46
<i>Wheat Bran.</i>						
1. Bran, T. E. Simpson—Merlin	15.00	7.86	4.20	8.58	6.29	58.07
2. Bran, Goldie Milling Co., Ayr	13.75	11.11	3.70	7.36	2.90	61.17
3. Bran from fall wheat.....	14.56	9.19	3.20	10.59	6.05	56.41
4. Bran from Manitoba wheat	13.50	12.23	4.50	7.04	5.62	57.11
5. Bran, Frontenac Milling Co.	17.53	11.71	3.11	8.41	5.09	54.15
6. Wheat bran—Guelph.....	14.87	8.55	3.62	9.54	6.31	57.11
7. Wheat bran—Tillson & Co.	16.87	11.00	3.62	9.54	6.31	52.66
8. Bran—Meyer's Milling Co.	15.25	12.24	4.43	9.21	5.20	53.67
9. Bran.....	14.21	9.75	3.10	7.20	5.40	60.34
10. Bran.....	14.30	10.43	3.91	9.96	2.20	59.20
Average	14.99	10.40	3.74	8.74	5.14	56.99
<i>Low Grade Flour</i>						
Low grade flour—T. E. Simpson	12.99	8.71	2.25	0.29	1.51	74.25
Flour—T. E. Simpson, Merlin..	9.85	13.37	4.85	0.49	1.93	61.51
Low grade flour—R. Harvey...	13.00	10.97	3.65	0.53	2.21	69.64
Average	11.94	11.02	3.58	0.44	1.88	71.13
Thorp's crushed wheat.....	13.73	7.92	2.59	3.32	1.62	70.82
<i>Shorts.</i>						
1. Shorts—R. Harvey.....	15.60	8.59	3.99	3.32	3.91	64.59
2. Shorts—Pembroke Mill Co.	16.16	9.37	4.55	5.93	5.08	58.91
3. Shorts—T. E. Simpson....	16.25	11.37	5.02	5.51	4.52	57.33
4. Shorts—Frontenac Mill Co.	16.06	8.21	4.26	3.31	3.95	64.21
Average	16.01	9.38	4.46	4.52	4.37	61.26

varies between 2.50 and 6 per cent. We are glad to say, on account of the widespread use of wheat middlings, that the samples examined were entirely free from corn bran or other adulterants of like character.

WHEAT BRAN.

In the above table the percentage composition of ten samples of wheat bran shows a variation of from 13.50 to 17.53 per cent. of protein, and from 3.10 to 4.50 per cent. of fat. It will be noticed that some of the samples of bran analysed were obtained from fall wheat, others from Manitoba spring wheat, and still others are not designated. Every sample of bran was of good quality, and contained no adulterants which could be detected other than a few particles of broken wheat.

Wheat bran is probably one of our best known by-products. It contains protein, fat, ash, and soluble carbohydrates in such proportion as to make it an exceedingly valuable component of a dairy ration. Only two samples of the ten analysed showed less than 14 per cent. of protein. If the percentage of protein falls much below 14 per cent., the chances are that the bran has been mixed with something of inferior quality. In the mentioned case, however, no adulterant could be detected.

LOW GRADE FLOUR.

Three samples of low grade flour were analysed. These show an average of 11.94 per cent. of protein, as well as 3.58 per cent. of fats, and 71.13 per cent. of soluble carbohydrates. For some reason the quantity of protein in sample No. 2 falls considerably below the average. It will be noticed that the percentage of moisture is much higher than in samples 1 and 3. As stated in the introduction, a high moisture content in a feeding-stuff is a decided detriment, in that it not only decreases the actual amount of food components present, but it also favors the growth of moulds, and these hasten the decomposition of valuable food materials.

The results of experiments at some of the American Stations furnish evidence that the amount of soluble carbohydrates and fat is very greatly reduced by the action of moulds. In the case of bread as much as 75 per cent. of the dry matter was lost. This loss was noted chiefly in the carbohydrates. In other experiments with peanut cake the fat content was reduced by mould from 12 to less than 1 per cent. While the writer does not mean to state that the percentage of moisture noticed in sample No. 2 is sufficient to cause such serious loss as that just mentioned, yet the amount of moisture is sufficient to warrant a note of warning on this point. It might also be added that in some cases farmers sustain very serious losses in valuable food materials through improper attention to the ground chop and corn meal. In all cases where the new grains are ground, especially if the grains be soft, the chop should be spread out in some convenient bin or floor in order that the excess of moisture may have a chance to evaporate. In this way the loss resulting from the development of moulds or bacteria may be eliminated or checked to a great extent.

The samples of flour designated as "low grade," although not suitable for bread-making purposes, could be advantageously and economically used as food for pigs. It must be remembered, however, that flour is a very heavy food, and unless it is fed along with some other feeding-stuff of a lighter character, there is danger that the digestive apparatus of the pig may become clogged. Because of this danger, greater care must be observed in feeding pigs on a ration of milk and flour than in feeding milk and middlings, as the latter food contains quantities of bran, which enlighten a food very effectively.

Only one sample of crushed wheat was examined. This sample is of very good quality, and would make an excellent substitute for shorts in a ration for young pigs.

SHORTS.

The figures in the above table show an average of 16.01 per cent. of protein, 4.46 per cent. of fat, and 61.26 per cent. of soluble carbohydrates. This by-product possesses very high feeding value. It might be used to advantage in supplementing a ration low in protein, provided the animals could be induced to eat it readily. For young pigs, or breeding sows this by-product makes an excellent feed. The young pigs eat it readily and thrive admirably on a ration of shorts and skim milk. In the estimation of many practical feeders this is one of our most valuable by-products, although not equal to low grade flour for fattening hogs.

BEESWING.

This by-product is the outside layer of the wheat hull, and is, therefore, a special form of bran. This bran is removed from the wheat (which has been previously moistened with cold water), by the action of a cylinder running at a high rate of speed against an outside case. In this process the kernel of the wheat remains unbroken.

A glance at the analysis is sufficient to show us that this by-product contains a larger amount of crude fibre than does our average bran. Again, we note that the average amount of protein in ordinary brand is approximately fifteen per cent., while in the by-product under discussion the protein content drops to less than ten per cent., which is slightly above the minimum allowable percentage of protein in any feed. The least quantity of protein that any food should contain is 7 per cent. That is to say, it is doubtful if any feed with less than 7 per cent. of protein is a wise purchase unless under exceptional circumstances. Even average cob meal contains nearly 8 per cent. protein. Experiments have shown that, as a rule, when the quantity of protein present in a feed falls below 7 per cent, its place is taken by crude fibre, consequently the purchaser does not receive any greater amount, if as much, of the more digestible forms of carbohydrates than if the protein were furnished. The by-product at present under discussion proves to be a quite marked exception to the general rule. In a series of digestion experiments which

we have conducted with this food, we have found that not only is there a very high percentage of digestible soluble carbohydrates present, but the crude fibre, also possesses a high digestion co-efficient. It must also be remembered in this connection that in the samples of beeswing examined we have found more than 7 per cent. of protein.

COTTON SEED MEAL.

This by-product in the manufacture of cottonseed oil is obtained in the following manner : The hull of the cottonseed is removed, the kernel is then cooked and subjected to pressure to remove the oil. The residue (cotton seed cakes) is then pulverized.

The five samples examined were fairly constant in composition. Cottonseed meal is rich in protein, and contains also a high percentage of ether extract or fat.

This by-product must be used with caution, as calves and pigs have been killed by continued use of this food. In the case of milch cows a few pounds per day may be fed, but many owners of live stock regard it as very dangerous food to place at the disposal of the ordinary hired man, because carelessness in regard to the number of pounds of this by-product fed will very quickly result in serious derangement of the digestive organs of the animals. Furthermore, in a ration for young pigs it has been frequently noticed that if cottonseed meal be used to balance a ration of these animals, the animals are apparently poisoned thereby. For the average feeder, therefore, the advice would be to leave cottonseed meal out of a ration intended for these animals.

COTTON SEED HULLS.

Four samples of cottonseed hulls were analyzed. As will be noticed, the percentage of protein is very low. Average percentage 4.45. The percentage of crude fibre is very high. This by-product is not recommended as a cattle food, as it contains a very low percentage of protein and fat. Moreover, the crude fibre is not only largely indigestible, so that the digestive juices of the animal do not extract much nutriment from it, but, what is still more important, crude fibre renders the rest of the food less digestible by protecting it from the action of the digestive fluids. This by-product is, therefore, practically worthless, and to the average farmer it would be dear at any price. For, not only is the quantity of protein extremely small, but by far the larger percentage of carbohydrates exists in a very indigestible form. To move these indigestible ingredients from one part of the alimentary canal to another necessitates the expenditure of energy. Thus we see that energy derived from a digestible portion of a ration may be used up in eliminating the indigestible portions from the system. Materials such as cotton seed hulls which contain large quantities of crude fibre in a highly indigestible form are, therefore, a decided detriment to a ration.

Foods analyzed.	Crude Protein.	Moisture.	Ether Extract.	Crude Fibre.	Ash.	Soluble Carbo-hydrates.
<i>Beeswing.</i>						
1. Beeswing—P. McIntosh....	9.36	7.21	0.47	19.56	2.01	61.39
2. Beeswing, 1903.....	2.23	7.42	0.39	18.76	2.12	61.08
3. Beeswing, 1903.....	9.20	6.17	9.38	16.25	2.73	65.27
Average	9.60	6.93	0.47	18.19	2.29	62.58
<i>Ground Cotton Seed Meal.</i>						
1. Cotton Seed Meal.....	44.61	2.68	14.49	6.14	7.00	25.08
2. Cotton Seed Meal.....	44.17	7.42	14.31	3.35	6.90	25.83
3. Cotton Seed Meal.....	43.65	8.65	13.98	5.70	7.10	20.92
4. Cotton Seed Meal.....	44.10	4.43	14.69	5.63	7.31	26.84
5. Cotton Seed Meal.....	44.37	6.51	10.75	3.05	6.23	25.09
Average	44.18	5.94	13.65	4.78	6.91	24.54
<i>Cotton Seed Hulls.</i>						
1. Cotton seed hulls.....	5.14	9.51	1.37	49.32	2.21	32.45
2. Cotton seed hulls.....	3.98	10.21	1.16	45.17	1.89	37.59
3. Cotton seed hulls.....	4.98	9.58	1.31	46.37	2.34	35.42
4. Cotton seed hulls.....	3.72	9.63	1.29	45.53	2.19	37.54
Average	4.45	9.73	1.31	46.60	2.16	35.75
<i>Linseed Meal.</i>						
1. Oil Cake—G. Oil Cake Co..	32.81	9.45	7.42	10.96	6.10	33.26
2. Linseed Meal.....	31.37	9.17	7.26	11.33	6.48	34.40
3. Oil Cake—Sample A.....	31.37	9.17	7.26	11.33	5.49	35.38
4. Oil Cake—Sample B.....	33.94	10.38	7.33	11.57	6.28	30.50
5. Flax Seed Meal—W. Hower.	23.87	4.90	11.76	6.10	5.41	47.96
6. Linseed Meal.....	32.65	9.90	7.55	12.36	5.83	31.81
7. Oil Cake (1903).....	32.60	8.43	8.20	10.93	5.97	33.87
8. Oil Cake (1903).....	31.51	9.90	7.42	11.60	6.25	33.32
9. Oil Cake (1903).....	31.96	10.47	7.12	11.12	6.46	32.79
10. Linseed Meal.....	30.27	8.93	3.61	8.93	4.73	43.53
11. Linseed Meal.....	27.31	10.15	8.23	10.62	5.62	38.07
12. Linseed Meal.....	26.54	7.64	4.32	12.17	6.01	43.32
13. Linseed Meal.....	29.12	9.21	4.46	9.39	5.93	41.89
Average	30.41	9.06	7.07	10.64	5.89	36.93
<i>Gluten Meal.</i>						
1. Maize Gluten—Wilson....	15.00	6.51	3.73	6.65	1.80	66.31
2. Gluten Meal.....	24.36	2.24	7.97	5.13	0.77	59.53
3. Gluten Meal.....	31.50	9.43	8.73	1.27	0.68	49.39
4. Gluten Meal.....	28.65	8.79	6.84	1.43	0.84	53.45
5. Gluten Meal.....	16.23	6.31	7.02	5.64	0.39	64.41
6. Gluten Cake.....	19.27	10.82	5.21	5.93	0.64	58.13
7. Gluten Cake.....	22.37	4.73	9.23	4.72	1.58	57.37
8. Gluten Meal.....	29.65	7.61	6.27	3.65	0.89	51.93

Foods Analyzed.	Crude Protein.	Moisture.	Ether Extract.	Crude Fibre.	Ash.	Soluble Carbo-hydrates.
<i>Gluten Meal.</i>						
9. Gluten Meal.....	30.90	5.12	10.22	5.81	0.92	47.03
10. Gluten Meal.....	27.35	5.43	15.00	1.29	1.25	49.68
11. Gluten Meal.....	21.73	9.64	8.83	4.31	0.68	54.81
12. Gluten Meal.....	18.59	8.23	7.21	6.27	0.75	58.95
13. Gluten Meal.....	17.65	5.61	7.42	6.15	0.83	62.34
14. Gluten Meal.....	34.74	6.91	5.71	2.00	0.37	50.27
15. Gluten Meal.....	19.57	7.54	8.31	1.82	0.57	62.19
16. Gluten Meal.....	25.44	8.25	14.78	4.61	0.62	46.30
17. Gluten Meal.....	25.86	4.64	10.21	1.52	0.92	56.85
18. Gluten Meal.....	19.73	9.10	10.62	5.98	1.15	53.42
19. Gluten Meal.....	27.34	8.85	9.21	1.05	0.68	52.87
20. Gluten Meal.....	29.63	8.06	8.25	2.25	0.72	51.09
21. Gluten Meal.....	28.70	5.92	10.12	2.93	0.50	51.83
22. Gluten Meal.....	34.90	6.87	6.91	1.07	0.74	49.51
Average.....	24.96	7.12	8.54	3.70	0.83	54.85
<i>Gluten Feed.</i>						
1. Gluten Feed.....	27.73	11.59	3.06	6.97	0.21	50.44
2. Gluten Feed.....	27.51	6.33	8.91	8.25	1.19	47.81
3. Gluten Feed.....	24.87	11.50	7.23	4.49	0.26	51.65
4. Gluten Feed.....	23.75	9.42	6.44	6.82	1.63	51.94
5. Gluten Feed.....	25.75	5.45	6.13	5.73	0.85	56.09
6. Gluten Feed.....	28.34	9.55	4.21	6.15	0.89	50.86
7. Gluten Feed.....	26.43	10.15	8.23	7.36	0.42	47.41
8. Gluten Feed.....	26.21	5.42	7.52	5.75	0.87	54.23
9. Gluten Feed.....	22.98	8.63	6.82	6.50	0.93	54.14
10. Gluten Feed.....	27.37	10.45	12.18	3.92	0.56	45.52
11. Gluten Feed.....	23.58	8.43	8.40	5.17	0.72	53.70
12. Gluten Feed.....	26.79	9.27	9.61	3.99	0.64	49.70
13. Gluten Feed.....	23.21	6.23	9.82	4.25	1.14	54.85
14. Gluten Feed.....	25.92	9.47	12.65	5.42	0.62	45.92
15. Gluten Feed.....	24.61	6.42	7.73	6.49	0.43	54.32
16. Gluten Feed.....	26.81	8.62	5.23	6.83	0.92	51.59
17. Gluten Feed.....	24.32	8.94	3.66	6.62	1.61	54.85
Average.....	25.65	8.61	7.52	5.92	0.82	51.47
<i>Corn Chop.</i>						
1. Corn Chop—T. E. Simpson.....	11.07	8.79	4.76	3.10	1.18	71.10
2. Thorp's Crushed Corn.....	11.28	10.66	4.34	2.08	1.39	70.25
3. Corn Chop, 1902.....	9.58	11.32	4.37	2.35	1.73	70.65
4. Corn Meal, 1902.....	10.32	12.16	5.16	1.25	1.24	69.87
5. Corn Meal, 1902.....	8.61	10.34	5.03	1.37	1.00	73.65
6. Corn Meal, 1902.....	9.28	9.31	3.25	2.18	1.20	74.78
7. Corn Meal, 1902.....	9.54	4.20	3.21	2.60	0.98	79.47
8. Corn Meal, 1903.....	6.54	11.71	4.71	1.85	1.98	73.21
9. Corn Meal, 1903.....	7.32	11.15	4.44	1.46	1.76	73.87
10. Corn Meal, 1903.....	10.05	8.43	5.45	1.11	1.54	73.42
Average.....	9.36	9.80	4.47	1.93	1.40	73.04

LINSEED MEAL OR OIL CAKE.

This product is the residue left after extracting the oil from flaxseed with naphtha, benzine, or a similar solvent of oily matter. In the extraction of linseed oil by the old process the flaxseed was subjected to pressure. The new process admits of more perfect removal of the oil from the seed; therefore, linseed meal obtained from the "new process" as a rule, contains more protein and less fat than the "old process" meal. The extracted residue may be sold in the cake form, as broken or nutted cake, as ground oil cake, and as linseed meal. The linseed meal and the ground oil cake are, as the name would imply, both meals, and are different names for the same products. It is commonly sold in the ground condition as it is more convenient for feeding. Flax Seed meal is the name generally given to the ground, but unextracted flax seed.

The thirteen samples of linseed meal examined are all of "new process" manufacture. The table of composition shows an average of 30.41 per cent. of protein in the thirteen samples examined. Linseed meal is, therefore, a highly concentrated food, and may be used in moderate quantities to correct the deficiency of protein in some of our home-grown feeding stuffs. As this meal also contains a high percentage of crude fat, it may have a beneficial mechanical effect in rendering the passage of the other components of a ration through the alimentary canal less difficult.

Linseed meal has been advocated as a component of a ration for milch cows, and many of our most intelligent dairymen have fed it with good success. It is also claimed that a small quantity of linseed meal fed in a ration to horses will give these animals a glossy coat, which is an indication of a thrifty condition.

There are two kinds of linseed cake or meal, the one containing the hulls of the seed and the other the decorticated meal. The analysis in the foregoing table represents the composition of thirteen samples of the latter food. As a component of a ration for all kinds of animals, it is one which in the experience of a great number of practical feeders has given good results. Some feeders object to the use of this food, because when mixed with water it has a sticky consistency. This, however, should not be a serious objection if the results obtained from the use of this food indicate greater value than those obtained from the use of other by-products.

GLUTEN MEALS AND GLUTEN FEEDS.

Much confusion exists as to the meaning of the different terms applied to these by-products from the manufacture of glucose and starch. They all come primarily from corn. The starch is largely extracted from the corn, leaving a by-product rich in protein. The different products found in the markets, sold under the name of gluten, are the by-products obtained in the process of separating the starch from the other part of the grain. The corn is first soaked in water for some hours, then coarsely ground and

rubbed between millstones, which removes the bran and sets free the starch grains. The material is then placed upon a sieve of bolting cloth, which allows the starch and gluten to pass through, while the germs and hulls remain on the sieve. The starch and gluten which go through the sieve are then forced through tanks of water and separated.

The hulls and germs of the corn are dried and sometimes placed on the market directly. The residue obtained from the settling tanks is dried and sold as gluten meal, and sometimes the corn hulls and germs are sold separately under the trade names of corn bran and germ meal or corn oil cake. When all the by-products above mentioned are mixed, the material is called gluten feed, and may be regarded as corn minus its starch.

Gluten feed is an excellent material, but not the equal of gluten meal. The chief difference in the composition of these two materials is in the amount of protein, and the relative values can be estimated very closely by the percentages of these constituents contained in them. The gluten feeds, owing to the presence of corn hulls, contain considerably more fibre and starchy material and less of the protein than do the gluten meal. In the foregoing tables it would be seen that the average composition of gluten meal and gluten feed is nearly the same, which leads us to believe that many of the soaked corn gluten meals have been wrongly named. They should more properly be called gluten feeds. In fact, the only true gluten meals analysed were numbers 3, 9, 14, 22. The twenty-two samples analysed were either secured on the market or forwarded by farmers in Ontario, and each sample was distinctly labelled gluten meal. It is important, therefore, to insist upon the necessity for a correct nomenclature in this matter, as these feed-stuffs are, comparatively speaking, new to feeders of live stock. The term gluten meal should be restricted as above defined, and not used for a mixture of much less feeding value. There is, of course, no objection to these by-products mixed together, but there is a very strong reason why such a mixture should not be sold under the name of the most valuable of its constituents.

Speaking of the feeding values of these materials, let me repeat what was stated in a previous part of this bulletin, that certain feeds rich in protein are also rich in ash material. Our analyses show that an exception is formed by concentrated feeds, which are by-products, where the seeds are treated with large quantities of water, as in the case of gluten meals and gluten feeds. Such feed should be fed with caution to young stock that consume but little roughage, and require a liberal supply of ash material for the formation of bone.

CORN CHOP.

Ten samples of corn chop were analysed. The figures in the above table show a variation of from 6.54 to 11.28 per cent. of protein. Comparing the average percentage composition of corn chop with that of wheat middlings, we note that the figures show a very slight difference

in the fat content of these two feeding-stuffs. The average protein content is, however, about 5 per cent. higher in the case of middlings. The percentage of crude fibre is much the same in both middlings and corn meal. Another matter which the practical agriculturist has to consider in feeding young and growing animals is the quantity of ash, or bone forming material, which a food may contain. In comparing the average percentage of ash in wheat middlings with that of corn the figures reveal a very marked difference in favor of the wheat middlings.

It has been said in another part of this bulletin, that the ash constituents of a feeding-stuff are of great importance to young and growing animals. The fact that gluten meal and such by-products contain a low percentage of ash has also been mentioned. These products, however, are used by comparatively few of our farmers. Corn meal, on the other hand, is used very extensively in certain parts of Ontario; therefore a few facts concerning the quantity and quality of the ash of cornmeal as compared with the ash material required by the animal body may not be out of place. The complaint has often been heard that hogs fed on corn alone have weak bones. The reason for this is very apparent when we consider the amount of ash required by these animals for the building up of the bone, with the percentage of ash indicated in the foregoing table, which is 1.4 per cent., or 1.4 pounds in 100 pounds of the corn meal. Of this 1.4 pounds .032 of a pound is lime and .67 of a pound is phosphoric acid. *Now, according to Professor Henry of Madison, Wis., 534 pounds of corn will produce 100 pounds of gain. And since this amount of corn contains 7.47 pounds of ash, of which .69 per cent. is phosphoric acid and lime, there is only .051 pounds or the principal bone-forming materials supplied to the growing hog. Now, let us consider the requirements of the hog. His increase in weight is 100 pounds, of which, according to Lawes and Gilbert, 2.9 per cent. is ash. Of this 99.0 per cent. is bone ash. From these figures it is apparent that in 100 pounds gain 2.87 pounds of bone ash has been formed, of which 97.25 per cent. is made up of lime and phosphoric acid, or 2.79 pounds of lime and phosphoric acid are necessary under normal conditions to supply the ash material necessary for 100 pounds of growth. Therefore, if corn meal be fed alone there will be a deficiency of 2.70 pounds of the necessary ash constituents of bone. Hence, it is not surprising that animals fed on such a ration are weak boned.

What has been said regarding the ash material required for the building up of the bone in the case of the growing hog is, in the main, true of all young and growing animals. Such animals require from five to seven per cent. of ash in their food, and of this about 97.0 per cent. should be lime and phosphoric acid. Therefore when corn is fed to young animals it should be mixed with other foods containing a much higher percentage of ash in order that the bone forming material of these animals may be furnished in sufficient quantity.

*Iowa Agriculturist, April, 1904.

Foods Analyzed.	Crude Protein.	Moisture.	Ether Extract.	Crude Fibre.	Ash.	Soluble Carbo-hydrates.
<i>Corn Bran.</i>						
Corn Bran—P. McIntosh	11.81	8.32	2.98	11.02	1.35	64.52
Corn Bran—Tilson & Co.	8.75	7.12	3.73	15.89	1.40	63.11
Corn Bran, 1903.	8.21	5.42	1.01	16.32	0.99	68.05
Corn Bran, 1902.	7.42	4.21	1.25	19.54	1.54	66.04
Corn Bran, 1902.	7.00	4.79	1.13	18.60	0.71	67.77
Average	8.64	5.97	2.02	16.27	2.20	65.90
<i>Corn Ensilage.</i>						
1. Ensilage, Jan. 17, 1903.	9.63	5.48	2.32	31.55	6.16	44.86
2. Ensilage, barn silo, Jan. 29.	10.06	7.35	2.00	32.82	6.54	41.23
3. Ensilage, dairy silo, Jan. 31.	10.50	10.21	2.55	27.65	5.59	43.40
4. Ensilage, dairy silo, Feb. 6.	10.65	9.65	2.42	33.20	5.89	38.19
5. Silage, air-dried, Feb. 21st.	10.87	10.62	2.31	35.40	5.91	34.89
6. Silage, air-dried, Mar. 7th dairy	10.92	10.92	2.04	34.27	6.23	35.62
7. Silage, air-dried, Mar. 19th dairy.	11.01	10.63	2.00	33.60	6.80	35.96
Average	10.52	9.26	2.25	32.64	6.16	39.17
<i>Corn of 1903, Percentage as Calculated in Water-Free Substance.</i>						
1. Green Corn, 1903.	10.43	.....	2.78	27.37	6.81	52.61
2. Field Cured Corn, 1903	10.04	.....	1.31	32.64	5.15	50.86
3. Silage, 1903.	9.91	.....	2.73	24.35	7.49	55.52
4. Silage, 1903.	8.53	.....	2.91	31.52	5.92	51.12
5. Silage, 1903.	7.49	.....	2.85	34.20	6.20	49.26
6. Silage.	8.21	.....	2.89	30.27	7.01	51.62
7. Green Corn, 1903.	9.99	.....	2.37	33.26	6.44	47.94
8. Field Cured Corn, 1903.	9.49	.....	1.41	36.83	4.94	47.33
9. Silage, 1903.	9.22	.....	2.65	27.18	8.05	52.90
Average	9.26	.....	2.43	30.85	6.44	51.02
<i>Oat Hulls or Oat Bran.</i>						
1. Oat Bran—P. Stewart.	6.04	8.24	1.30	25.13	1.21	58.08
2. Oat Hulls, 1903.	5.43	8.97	0.27	31.65	6.52	47.16
3. Oat Hulls, 1903.	3.91	10.84	0.21	35.44	5.43	44.17
4. Oat Hulls, 1903.	2.26	9.38	0.69	32.50	4.47	50.70
5. Oat Hulls, 1903.	7.59	8.72	0.54	28.64	6.10	48.41
6. Oat Bran—Tilson & Co.	8.44	4.07	0.53	31.25	4.96	50.75
7. Oat Bran—D. R. Ross.	7.13	9.59	5.11	30.22	5.85	42.00
8. Ground Oat Hulls.	11.88	7.85	0.76	27.48	2.63	49.40
9. Oat Hulls—Martin Bros.	6.50	9.59	0.89	15.34	7.93	59.75
10. Ph. 44 Oat Bran.	7.70	4.10	1.92	36.15	3.80	46.33
Average	6.74	8.07	1.16	29.38	4.90	49.75

CORN BRAN.

What has been said regarding oat hulls holds true, in a general way, of corn bran. This by-product bears to corn the same relation that bran and oat hulls bear to wheat and oats. Corn bran possesses a very low feeding value, but unless added to a feed in large quantities it is not objectionable. If, however, large quantities of such material be mixed with some of our more concentrated by-products, the mixture is worth less money than a concentrated by-product not so adulterated. If the corn bran be sold as a by-product pure and simple, then the buyer has no one but himself to blame if the results obtained from feeding such food prove unsatisfactory. The intelligent feeder of live stock will have very little to do with materials which, like this feed, contains less than 9 per cent. of protein, because most farms produce enough coarse fodder to supply material of such low grade. It is very true that foods of this general character are sold at a lower price per ton than wheat bran, middlings, gluten meal, and linseed meal, but it should be remembered that a ton of linseed meal contains almost four times as much protein as was present in this feed, and when considered from this standpoint, it may be found that that which seems to be cheapest at the time is really the least economical in the end.

CORN GROWN 1902.

Seven analyses of corn ensilage show an average of 10.52 per cent of crude protein in the air-dried food. The object of making these several analyses was to study the chemical changes which take place in the protien compounds of corn in the silo. This table does not show any column for amide compounds, but I may say that our work, so far as we are able to judge from present results would indicate that a certain amount of the proteid bodies revert to a lower form during the process of fermentation. The figures on the above table would indicate that the corn in the dairy silo in 1902 was of quite constant composition.

ANALYSIS OF CORN OF 1903, PERCENTAGE CALCULATED IN WATER FREE SUBSTANCE.

The reader will be at once impressed with the fact that whatever be the food value of green corn or corn ensilage, it possesses but a very low percentage of protein. The nine samples analysed in our laboratory show an average of only 9.26 per cent. in water-free substance. Bearing in mind what has been said in the introduction regarding the value of protein in the food of our farm animals, it is apparent that the intelligent feeder must supplement a ration, consisting largely of green corn or ensilage, with a certain amount of a more nitrogenous food.

OAT HULLS OR OAT BRAN.

This product is obtained by removing the outer shell of the oat grain. The oats are first kiln dried and are then run through a pair of stones. The product is then run over a wire screen and all the dust is screened out. The kernel and hulls are then passed through a fan which removes the hull and leaves the kernel.

The figures in the above table show a wide variation in the composition of oat hulls. In discussing the value of cotton seed hulls we point out the poor economy of feeding a produce which contains a high percentage of crude fibre. A glance at the foregoing table shows that oat hulls contain a considerable quantity of crude fibre. This fact would at once convince us that this by-product possess a very low feeding value. But in sections where cattle are fed large quantities of corn meal, oat hulls or similar food-stuffs may exercise a beneficial mechanical effect, in that the food is made lighter and more easily digested.

OAT DUST.

In the manufacture of oat-meal or rolled oats the grain is first kiln dried and then passed through a stone to remove the hulls. The product is then passed over a screen and the dust removed. This dust is largely composed of a layer which lies between the kernel of the oat and the hull. Small particles of the broken oat also pass through the screen and these are included in what is termed oat dust.

"Oat dust is not, as has been stated on several occasions, simply dirt and rubbish; on the contrary it is a pure by-product of the oat." Of course, the writer does not mean to claim that it would be impossible to mix an inferior grade of feed with the dust from the oat, and respect the mixture to be pure oat dust. But the combined chemical and microscopic examinations at twenty-three samples of this by-product failed to detect in a single case any foreign material other than finely divided particles of oat hulls, which under the method of manufacture can scarcely be looked upon as adulterant.

Comparing the average composition of oat dust with that of wheat bran, we note that the average quantity of protein in the latter feed is considerably lower than that in the bran. Therefore, if we take the quantity of protein and fat as the standard of purchase,—and it can hardly be denied that such is the correct standard, since materials containing considerable protein are the only ones suitable as additions to the feeding material of the farm,—wheat bran must be regarded as a much more valuable material than oat dust:

The objection might be raised that the purchaser is not getting the carbohydrates in the high-grade material that he would get in some of our lower grade feeds (oat dust for example); but it must be remembered that the feeding materials of the farm usually contain an abundance of carbohydrates. To such an extent is this true, indeed, that home grown

Foods Analyzed.	Crude protein.	Moisture	Ether extract.	Crude fibre.	Ash.	Soluble carbo- hydrates.
<i>Oat Dust.</i>						
1. Flavell's Oat Dust, 1900..	9.78	6.60	5.73	18.16	4.50	55.23
2. Tillson's Oat Dust.....	10.97	7.17	5.53	22.60	6.23	47.50
3. Oat Dust—D. R. Ross....	13.00	10.05	4.17	16.75	5.37	50.66
4. Oat Dust, 1902.....	9.37	10.57	4.57	13.25	3.21	59.03
5. Oat Dust, 1902.....	10.25	9.53	3.65	9.53	5.48	61.45
6. Oat Dust, 1902.....	7.62	13.21	4.25	10.67	6.62	57.63
7. Oat Dust, 1902.....	11.54	8.20	2.97	8.75	4.71	63.83
8. Oat Dust, 1903.....	6.75	10.58	3.57	13.73	4.29	61.08
9. Oat Dust, 1903.....	12.63	7.21	5.61	25.25	6.08	43.22
10. Oat Flour—D. R. Ross....	13.56	6.92	5.95	6.71	4.60	62.26
11. Sutherland's Fine Meal...	19.30	5.34	5.74	12.20	2.52	54.90
12. Sutherland's Black Dust..	10.43	7.71	5.29	13.91	6.41	59.25
13. Oat Dust, Tillsonburg....	13.85	5.05	5.33	18.25	3.28	54.24
14. Oat Dust, Meyer's Mill Co.	11.07	11.11	4.83	5.15	5.95	61.89
15. Oat Dust, P. Stuart.....	16.37	7.60	5.89	6.73	4.05	59.36
16. Oat Dust, Tillsonburg....	16.52	12.10	5.75	15.15	4.15	46.23
17. Oat Dust, J. Wilson, Fergus	13.06	14.39	6.90	11.23	2.98	51.44
18. Oat Dust, R. Martin Bros.	14.22	12.00	4.61	7.21	2.42	59.54
19. White Oat Dust.....	14.42	12.13	6.03	5.80	1.90	59.72
20. Mill Dust, 1903.....	8.52	9.53	3.21	15.53	3.91	59.30
21. Mill Dust, 1903.....	8.95	13.61	3.54	29.14	3.47	41.29
22. Pearl Oat Dust.....	11.99	13.35	5.21	4.10	1.85	63.50
23. Pearl Oat Dust.....	10.16	10.21	4.15	5.05	1.54	68.89
Average.....	11.93	9.75	4.76	12.82	4.15	56.58
<i>Oat Siftings.</i>						
1. Oat Siftings—P. Stuart....	17.13	10.21	3.30	18.21	2.68	48.47
2. Oat Siftings, 1902.....	14.86	9.37	3.21	19.15	3.10	50.81
3. Oat Siftings, 1902.....	11.21	13.65	2.61	18.44	2.17	51.89
4. Oat Siftings, 1902.....	16.24	8.39	4.52	17.66	1.59	51.60
5. Oat Siftings, 1902.....	12.70	10.25	3.13	18.35	1.39	54.18
Average.....	14.33	10.37	3.36	18.36	2.19	51.39
<i>Oat Feed and Oat Meal.</i>						
1. Oat Feed—W. Thompson.	10.41	5.24	3.52	8.22	2.53	74.06
2. Feed Oatmeal—R. Martin	17.07	10.31	3.97	8.25	4.73	55.67
3. Oats coarsely ground....	12.38	8.43	3.17	11.40	3.00	61.62
4. Oats kiln dried.....	11.60	9.92	4.15	9.56	4.01	60.76
5. Oatmeal.....	16.95	13.25	7.31	0.83	1.85	59.81
6. Oatmeal.....	12.80	11.17	8.24	0.66	1.29	67.84
7. Hulled Oats.....	16.00	9.20	6.25	1.89	2.36	64.30
<i>Mill Feed.</i>						
1. Mill Feed—P. McIntosh..	7.94	13.25	3.29	17.87	5.49	52.16
2. } Residue from patent Cer-	9.23	7.42	1.01	27.51	10.97	43.86
3. } eal Foods.....	8.50	9.31	.98	27.78	9.34	44.09
4. Mill Stuff—W. Bacon....	4.75	6.58	1.56	34.35	5.34	47.42
5. Mill feed, 1902.....	8.76	12.36	3.10	19.52	4.76	51.50
6. Mill feed, 1902.....	9.27	10.52	2.75	16.24	5.32	55.90
7. Mill feed.....	12.98	10.21	4.43	9.80	2.15	60.43
8. Mill feed.....	11.63	8.37	4.26	7.21	3.09	65.44
9. Mill stuff.....	6.54	9.67	2.15	25.42	6.53	49.69
10. Mill stuff.....	3.22	10.72	1.69	20.62	7.42	56.34
11. Mill stuff.....	3.49	10.90	1.25	24.44	7.15	52.77
12. Mill stuff.....	4.84	9.62	1.11	21.27	6.21	56.95
Average.....	7.60	9.91	2.30	21.00	6.15	53.04

carbohydrates of higher quality than are furnished by many of these feed substitutes are often wasted on the farm. There is a class of feeders, however, to whom feeding-stuffs low in protein and which contain relatively large amounts of carbohydrates are valuable, namely, those who raise nothing themselves—city feeders of horses and stall-fed cattle. To these feeders, therefore, the quality of the carbohydrates is of greater importance. In the case of the horse, the animal is not provided with the extensive digestive apparatus of the cow. Nevertheless, he requires bulky material in connection with his grain, and he also requires that this bulky material be of good quality.

Referring to the table of composition we notice that the amount of total carbohydrates in oat dust is high, amounting to 69.40 per cent. Of this 12.82 per cent. appears in the form of crude fibre, the remaining 56.58 per cent. being soluble carbohydrates (starch, sugar, gums, etc.). If, therefore, the procuring of carbohydrates were the object of the purchase, oat dust should command a high price, inasmuch as this food contains only a moderate amount of these in the form of crude fibre.

OAT SIFTINGS.

Five samples of oat siftings indicate an average of 14.33 per cent. of protein. The fat content is also well in advance of many of the by-products on our markets. The percentage of crude fibre is rather higher than we would have expected in such a food. The microscopic examination, however, revealed the presence of only particles of finely divided oat hulls which could hardly be considered as an adulterant.

OAT FEED AND OATMEAL.

Sample No. 1 of this table must be considered a low grade food since it contains less than 11 per cent. of protein and less than two per cent. of fat.

Samples Nos. 2 and 7 of this table contain sufficient quantities of protein and fat to warrant us in classifying them as high grade foods. Such a food as No. 7 when mixed with milk or swill would make an excellent food for young pigs.

Two samples of oatmeal were analysed. As this food is not used to any extent as a cattle food, it is quite unnecessary to discuss the variation in composition.

Two samples of oats were analysed. In discussing the composition of oat dust, we observed that horses were usually fed on a ration consisting of bulky food and grain. In most cases the grain ration is made up largely of oats. It is interesting, therefore, to note that the amount of protein in the oat grains is low as compared with some of our concentrated by-products, and yet we seldom hear of oats being replaced in a ration for working horses by any of the highly nitrogenous materials

on our market. It may be that the quality of the proteids of the oat grain may have something to do with it; or the amount of fat may influence its nutritive value. Whatever be the cause we know that a component of a ration for work horses this special grain is of particular importance. Let us remember, however, that oats vary as greatly in composition as do some of the by-products we have examined, and that it is important that the amount of protein in oats be as large as possible. Remembering this, the intelligent feeder will select the variety of this particular grain which gives the greatest yield with a corresponding decrease of crude fibre.

MILK FEED.

Comparing the average composition of the foods recorded in this table with those of oat dust, we find that the latter contains a much higher percentage of crude protein and a correspondingly lower percentage of crude fibre. The oat dust must, therefore, be considered the better of the two.

No experiments have yet been conducted at this station to show which of the two foods is the more digestible. We hope, however, to be able in the near future to furnish this very desirable information.

BARLEY DUST.

"This by-product in the manufacture of pot and pearl barley is obtained by continued scouring of the grain with a stone. During the process the dust is carried away by means of a suction fan. Should there be any oat grains in the barley, they would also be broken up in the process and would appear in the dust."

The ten samples show an average of 14 per cent. of protein, which is a fair amount in a feeding-stuff. It will be noticed however, that there is a very considerable amount of crude fibre in this product. For this reason we do not consider it as valuable for feeding purposes as it would be if less fibre were present.

The microscopic examination of these samples revealed in most cases considerable quantities of finely pulverized barley hulls. Such by-products as barley-hulls, because of their low digestibility, are very undesirable in a cattle food. Notwithstanding this fact, the samples of barley dust examined show a fairly high protein content, and might be advantageously fed to certain classes of keep animals.

MALT SPROUTS.

Dried grains and malt sprouts, by-products from distilleries and breweries, are frequently used as cattle foods. To obtain these products the grain is first caused to sprout, and as a result of this growth the starch of the grain is changed to sugar. The sprouts are then removed and sold by dealers, sometimes in the wet condition, but for shipment they are dried and put up in sacks or barrels.

Foods Analysed.	Crude Protein.	Moisture.	Ether Extract.	Crude Fibre.	Ash.	Soluble Carbo-hydrates.
<i>Barley Dust.</i>						
1. Barley Dust—Thompson ..	13.91	5.29	5.22	11.58	2.80	61.20
2. Barley Dust—Tillsonburg..	14.78	9.01	2.37	7.61	5.40	60.83
3. Barley Dust—H. Wilson...	14.50	12.90	1.22	8.51	3.00	59.87
4. Barley Dust—R. Martin...	17.13	9.37	2.03	10.95	3.21	57.31
5. Barley Dust, 1902	12.40	13.65	1.12	15.43	2.95	54.45
6. Barley Dust, 1902	15.37	10.40	2.16	19.71	3.05	49.31
7. Barley Dust, 1903	13.21	9.80	1.95	13.25	3.40	58.39
8. Barley Dust, 1903	14.30	11.43	2.30	8.97	2.91	60.07
9. Barley Dust, 1903	11.21	12.70	1.07	10.40	3.87	60.75
10. Barley Dust	13.51	10.75	1.87	17.41	3.51	52.95
11. Barley Hulls.....	13.72	11.53	2.83	29.37	3.23	39.32
Average	14.00	10.62	2.20	13.93	3.39	55.86
<i>Malt Sprouts.</i>						
1. Malt Sprouts	29.24	8.70	1.85	15.27	7.80	37.14
2. Malt Sprouts	29.44	8.90	1.74	17.39	6.44	36.09
Average	29.34	8.80	1.79	16.33	7.12	36.62
<i>Barley.</i>						
1. Crushed Barley, Thorp....	14.06	10.51	2.78	2.00	3.02	57.63
2. Barley Chop—T. E. Simpson	12.60	9.57	2.22	2.90	2.49	70.22
3. Barley—R. Harvey	12.90	9.63	2.21	3.58	1.52	70.16
4. Meal—Sent by M. Cohoe ..	14.48	5.66	1.84	4.65	3.05	70.32
5. Barley Meal	11.60	10.12	2.96	2.92	2.96	69.35
6. Barley Meal	10.35	12.16	3.51	1.93	2.14	69.91
7. Barley Meal	8.73	13.62	2.27	2.58	2.29	70.51
8. Barley Meal	10.43	9.54	2.25	2.98	1.58	73.22
9. Barley Meal	11.69	11.25	2.83	2.79	1.79	69.65
Average	11.88	10.23	2.54	2.92	2.32	70.11
<i>Dried Molasses Beet Pulp.</i>						
No. 1 Dresden.....	8.81	2.71	1.46	14.14	6.34	66.54
No. 2 Dresden.....	9.03	2.56	1.53	12.29	5.93	68.66
No. 3 Dresden.....	8.50	2.95	1.21	14.43	7.07	65.84
No. 4	8.35	3.40	1.00	13.60	9.44	67.21
No. 5	9.17	3.09	1.16	16.21	6.81	63.56
No. 6	8.22	2.69	0.89	15.43	5.99	66.78
*No. 7 Dresden.....	7.69	3.17	0.73	20.07	6.03	62.31
Average	8.54	2.94	1.14	15-17	6.37	65.84
<i>Stock Food.</i>						
1. Molassine, air-dried	9.63	3.46	0.13	11.28	10.26	65.24
2. Biddy's Calf Food	13.82	11.79	9.21	03.23	4.59	57.36
3. Calf Meal—Meyer's Mill Co.	12.57	4.53	4.54	13.62	3.75	60.99
4. Pratt's Animal Regulator..	9.18	8.09	4.38	03.97	10.23	64.10
5. Molasses Cattle Food.....	8.81	2.71	1.46	14.14	6.34	66.54
6. Molasses Cattle Food.....	7.69	3.17	0.73	20.07	6.03	62.31

* Sample No. 7 contains no molasses.

Only two samples of malt sprouts were analyzed. These show an average of 29.34 per cent. of protein. As will be noticed these two samples are practically the same in composition. It must not be inferred however, that the composition of this feeding-stuff does not vary. As a matter of fact there is a very noticeable difference in the composition of sprouts from any two breweries. Moreover, the samples from one plant frequently differ among themselves as much as the averages from different plants.

BARLEY.

Three of the samples analysed were obtained from a manufacturer, and six from dealers.

Barley fed alone is considered somewhat "heating," and if fed continuously is likely to cause skin troubles. When combined with other grains, however, such as oats, peas, and so forth, it gives good results. The table of analysis shows that the digestible protein is lower in barley than in oats and considerably higher than in corn. The carbohydrates, on the other hand, exceed those of the oats and fall below those in corn. Barley has also less oil than either of the two grains mentioned. When mixed with oats and ground previous to feeding, it is considered an excellent constituent of a ration for dairy cows. Some authorities claim that it has an influence on the quantity of the milk and butter. The impression appears to be prevalent among certain farmers of the Province that barley fed alone is poisonous. This statement will be given little credence by the majority of those who have had any experience in feeding the grain. It is true, as before stated, that barley is considered somewhat heating and may produce skin trouble, but that it is a poison is certainly not the case. The experience of prominent feeders, both in England and the United States, and in Europe "(it is used extensively in the latter place for the production of pork)" will allow us to regard barley meal as a very valuable component of a ration for farm animals.

DRIED MOLASSES BEET PULP.

This feeding-stuff consists of dried molasses and the pulp which remains as a residue from the manufacture of sugar from sugar beets. We have conducted a series of digestion experiments with this material and find it to be good feed for parties who do not have sufficient coarse feed for their stock; but beet pulp, like the coarse feeds of the farm should be supplemented by materials rich in protein. The writer is inclined to believe that the price asked for this material at the factory is altogether too high, and when the price is increased by the cost of transportation for long distance, the expense is certain to greatly overbalance the gains. Whether, therefore, it will prove to be an economical feed depends upon the price asked for it and the cost of the coarser home grown feeding stuffs. Beet pulp must be regarded purely as a substitute for the coarse fodders of the farm, and should be fed with caution to young stock.

Stock Food.

Several samples of what are usually termed "Stock food" have been examined. A glance at the above table will show that in some there is a very fair quantity of protein and fat, but it must be remembered that the cost of the nutritive components of foods when purchased in such form is much in advance of their real value. Moreover, the claims that by the use of condiments and spices the digestibility of other components of the ration can be increased and in this way a saving of food can be effected, have no basis in fact. As foods, pure and simple, therefore, the prices paid for stock foods are ridiculously high when compared with the price paid for some of our most expensive standard foods.

Another important point is the ash. As was pointed out the quantity of ash in a food for young and growing animals is very important. The ash of most of our home grown foods and the ash of many of the by-product of our mills furnish a very fair amount of bone forming material. A glance at the above figures shows that all of the stock foods examined contain very large quantities of ash. In most cases, however, the ash of condimental foods contains considerable quantities of potassium salts, which tax the excretory organs of the animal and are, therefore, a decided detriment.

Another claim made by dealers in stock food is that such foods are of a medicinal or stimulating nature, and are claimed to be particularly effective and valuable, not only for growing animals, but also for cows in milk and for horses. This claim, however, should carry very little weight with the intelligent feeder, since it is a well established fact that healthy animals need no medicine or stimulant.

The writer does not mean to insinuate that stock foods should not be used under any circumstances. On the contrary, we believe that they have their places. For example, feeders who are fitting their stock for the show have successfully used stock foods. Their place, therefore, appears to be in a ration for show animals, but probably it would be better to use such foods only in the last stage of the fitting process.

It is claimed by certain prominent feeders that a better bloom can be obtained by the use of small, and limited quantities of some stock food in the last stages of feeding. It must be remembered, however, that such feeders do not consider the cost of a feeding-stuff, and in such cases as these in which the cost of the food can be overlooked, stock foods may be used.

The following shows the composition of two substances from which it was proposed to manufacture a stock food. Readers will be struck at once with the comparatively small quantity of nutritive material which such a mixture would contain. As stated before, the claims that such foods increase the digestibility of other fodders have no basis in fact. Furthermore, the purchaser of stock foods is frequently assured that the secretion of the digestive fluids is very greatly increased by the use of certain condiments. That such, in certain instances, may be the case we have no doubt, but the price paid for these foods is likely to be far in advance of the gain.

Foods Analyzed.	Crude Protein.	Moisture.	Ether Extract.	Crude Fibre.	Ash.	Soluble Carbo-hydrates.
<i>Stock Food Ingredients.</i>						
Sphagnum Moss.....	3.33	12.92	1.21	49.23	1.45	31.86
Beet Sugar Molasses.....	10.87	22.31	.....	.....	10.63	56.19
<i>Poultry Feeds.</i>						
Western Poultry Food Co.....	40.34	4.18	6.59	1.90	17.42	29.57
Cypher's Chick Food.....	12.03	6.01	1.28	3.10	29.42	48.16
Morgan's Animal Meal.....	58.10	7.59	21.25	1.34	12.60	0.0
Sutherland's Seeds.....	9.73	3.84	3.67	15.39	4.79	62.58
Spratt's Chick Meal.....	24.41	3.92	5.73	1.81	5.80	58.33
Spratt's Feed for large fowl....	19.32	4.76	5.07	1.09	16.23	53.52
Spratt's Chick Food.....	15.19	8.31	7.18	7.51	7.02	54.79

POULTRY FEEDS.

The above table gives the average composition of seven distinct brands of poultry foods. These feeds are composed of the usual materials known to be of value in the feeding of poultry. Some of our recognized authorities on poultry feeding tell us that they believe it would be greater economy to purchase the ingredients of these foods separately. Other poultrymen, however, think they would rather pay the difference for the convenience of having a ready mixed poultry ration whereby they avoid the storing and subsequent care of a number of materials which are of limited use in the small quantities they would have to buy.

SUMMARY.

Only a few cases of actual adulteration has been found among the samples examined. In every instance the adulterated sample was forwarded to us by a feeder of live stock.

A considerable number of by-products, such as corn bran. oat hulls, and oat feed, etc., are of such inferior quality that they cannot, as a rule, be used to any profit.

An examination of the analysis of the feeds given in the foregoing tables, when considered in connection with the prices paid for these food materials will assist the purchaser in deciding which of the by-products is the most economical for his purpose.

At the present time the prices asked for cattle foods bear very little relation to their feeding value. That is, feed is retailed at so much per ton, whether it is rich in protein and well suited to supplement our ordinary farm foods, or whether it is a starchy food, and, therefore, of much less value in compounding suitable rations for cattle. Such being the

case, special care in the purchase of feeds and some knowledge of their chemical composition will be found of paramount importance in keeping the cost of feeding down to a point which will admit of a profit.

TABLE SHOWING AVERAGE COMPOSITION OF FOODS ANALYZED.

Foods.		Crude protein.	Moisture.	Ether extract	Crude fibre.	Ash.	Soluble Carbohydrates
Pea meal,	8 analyses	23.27	10.34	1.90	7.04	2.83	54.62
Pea hulls,	13 "	10.04	7.51	1.44	42.07	2.92	36.01
Mixed grain or chop,	21 "	12.81	11.27	4.61	11.00	3.96	56.35
Wheat middlings,	21 "	15.54	10.10	3.92	4.26	3.72	62.46
Wheat bran,	10 "	14.99	10.40	3.74	8.74	5.14	56.99
Low grade flour,	3 "	11.94	11.02	3.58	0.44	1.88	71.13
Shorts	4 "	16.01	9.38	4.46	4.52	4.37	61.26
Beeswing,	3 "	9.60	6.93	0.41	18.19	2.29	62.58
Cotton seed meal,	5 "	44.18	5.94	13.65	4.78	6.91	24.54
Cotton seed hulls,	4 "	4.45	9.73	1.31	46.60	2.16	35.75
Oil cake,	13 "	30.41	9.06	7.07	10.64	5.89	36.93
Gluten meal,	22 "	24.96	7.12	8.54	3.70	0.83	54.85
Gluten feed,	17 "	25.65	8.61	7.62	5.92	0.82	51.47
Corn chop,	10 "	9.36	9.80	4.47	1.93	1.40	73.04
Corn bran,	5 "	8.64	5.97	2.02	16.27	2.20	65.90
Corn ensilage,	7 "	10.52	9.26	2.25	32.64	6.16	39.17
Green corn and silage,	9 "	9.26	.....	2.34	30.85	6.44	51.02
Oat bran,	11 "	6.74	8.07	1.16	29.38	4.90	49.75
Oat dust,	23 "	11.93	9.75	4.76	12.82	4.15	56.58
Oat siftings,	5 "	14.33	10.37	3.36	18.36	2.19	51.39
Mill feed,	12 "	7.60	9.91	2.30	21.00	6.15	53.04
Barley dust,	11 "	14.00	10.62	2.20	13.93	3.39	55.86
Malt sprouts,	2 "	29.34	8.80	1.79	16.33	7.12	36.62
Crushed barley,	10 "	11.88	10.23	2.54	2.92	2.32	70.11
Dried beet pulp,	7 "	8.54	2.94	1.14	15.17	6.37	65.84

The above table shows the average composition of the samples of feeding-stuffs analysed in our laboratory. We have discussed each table separately, and, where possible, have emphasized points of difference, etc., which we consider of greatest practical value to the feeder of live stock. As mentioned in the introduction, the percentage of protein in a food is invariably considered of prime importance because our home grown crops are more likely to be deficient in this than in any other component. In selecting a food, therefore, we should aim at obtaining the greatest amount of protein for our money. There are certain serious objections, however, to some of our feeding-stuffs, which contain a very large quantity of protein. Cotton seed meal, for example, contains, on an average 44.18 per cent. of protein, but many of our best feeders do

not consider it a safe food to place on the hands of hired men. Many cases of milk fever and other diseases in dairy herds have been attributed to indiscriminate use of cotton seed meal. This food may be fed to advantage if care is observed as to the amount fed per day, the age of the animal, etc. All things considered, it might be wiser to make up any deficiency in protein in a ration by feeding another of the by-products mentioned (linseed meal for example). The addition of cotton seed meal to a ration for calves or pigs results in serious derangement of the digestive organs of these animals.

Pea meal, linseed meal, maize gluten, gluten feed, middlings, and wheat bran are by products which contain a large quantity of protein, and are, therefore, most valuable components for a ration intended for dairy cows. For fattening pigs, good results have been obtained from a mixture of skim milk and low grade flour. Shorts is an excellent food for young pigs. Oat dust and other feeds of like composition, if pure, furnish nutritive materials at economical prices. The purchaser must, however, be on his guard, as frequently feeds are presented for sale on our markets which are heavily adulterated with foreign material of little value. Only to-day a sample of what was supposed to be wheat bran was sent to our laboratory. Upon examination we found this sample to be adulterated with large quantities of finely ground barley bran. From the result of our investigation, however, we are convinced that goods obtained from the local manufacturers are usually of good quality. In some instances we have found the nutritive materials, especially protein, present in smaller quantities than we might have expected, but in most cases this deficiency was due, not to adulteration, but to the poor quality of the grain from which the by-product was obtained.

Regarding mill feed, oat hulls and such low grade materials little need be said. The tables of composition show them to be entirely unfit to feed as substitutes for pea meal, linseed cake, and such nitrogenous materials. There are cases, however, in which these feeding-stuffs might be used to advantage, but the feeder is likely to be misled in the purchase of these materials, because the price asked, judged from the cost of standard food materials would indicate value which they do not possess. Economical purchase, however, does not imply the purchase of the lowest priced foods. As previously observed many of the waste products of our mills are not altogether worthless, but it is important that purchasers should know what they are and what relation they bear to the standard feeds. In some cases finely ground materials are sold under fancy names and these in many instances are essentially inferior to ordinary farm roughage. Feeders of live stock should not be deceived in such a case by false claims or a fancy name, suggesting good quality or good origin. Purchasers are, therefore, advised to be on their guard in the selection of some of these so-called cheap by-products. It is safer, as a rule, to buy standard foods as their quality may be pretty accurately judged.

APPENDIX.

As stated in the introduction, the tables giving the percentage composition of the foods analysed furnish us with information regarding the total amounts of the different constituents present in foods, but as only that portion of the food which is digested is of direct use to the animal, it has been deemed advisable to append a table giving the approximate amounts of digestible nutrients contained in the various fodders. The data upon which some of these calculations are based are taken from the results reported in Bulletin No. 77 of the U. S. Department of Agriculture. The digestibility of a number of these feeding-stuffs under consideration has been determined at this Station, and in such cases we have used our own data in calculating the amounts of digestible nutrients.

As will be seen from the following table, the digestibility of the different foods varies markedly, and it must also be remembered that the digestibility of some foods varies under different conditions. Furthermore, in those foods which are marked thus * the digestible components have been calculated from the digestibility of American feeding stuffs of the same name, and the digestion co-efficients of these may vary quite widely from our own. Therefore, when using the figures which are given in the following table, the feeder must bear in mind that he is dealing with approximate quantities only.

The importance of the supply of protein in a ration has been sufficiently emphasized to require no further mention. It may be stated, however, that if an excess of the amount required to build up and repair the waste of the body be fed the protein may be converted into fat and deposited as such or used to produce heat and energy. For these purposes it is about as efficient as the carbohydrates, but it is far more expensive than the latter, and, therefore, only as much should be supplied to the mature animal as will be used in repairing the necessary breaking down of the nitrogenous tissues in the animal body. In the case of growing animals and such animals as are kept for the production of milk, wool, and so forth, an increased amount of protein in the food is necessary.

The matter of computing rations for the various kinds of animals raised on the farm is, therefore, an important one to the feeder, for since the protein, on the one hand, and the carbohydrates on the other, serve in the main different purposes in the animal economy, it is evident that relative amounts of these nutrients in the food should be considered. This relation is called the nutritive ratio, which means simply the relation of the digestible protein to the digestible carbohydrates and fat, the fat having been multiplied by 2.25 before adding it to the carbohydrates. The nutritive ratio is then found by dividing the carbohydrates plus 2.25 times the fat by the protein. In the following table the sum of the carbohydrates and fat thus obtained is given in the third column, which divided by the protein, as given in the second column, gives us the nutritive ratio of the food.

DIGESTIBLE NUTRIENTS IN STATED AMOUNTS OF FOOD STUFFS.

Kind and Amount of Food.	Total Dry Matter.	Pounds of Digestible Nutri- ents.			Nutritive Ratio.
		Protein.	Carbohy- drates† (Fat X 2.25)	Total.	
*Pea Meal 1 pound	.896	.193	.543	.736	1:2.8
2 "	1.792	.386	1.086	1.472	
3 "	2.688	.579	1.629	2.208	
4 "	3.584	.772	2.172	2.944	
5 "	4.480	.965	2.715	3.680	
†Pea Hulls..... 1 "	.924	.073	.440	.513	1:6.03
2 "	1.848	.146	.880	1.026	
3 "	2.772	.219	1.320	1.539	
4 "	3.696	.292	1.760	2.052	
5 "	4.620	.355	2.200	2.565	
6 "	5.544	.438	2.640	3.078	
7 "	6.468	.511	3.080	3.591	
8 "	7.392	.584	3.520	4.104	
9 "	8.316	.657	3.960	4.617	
†Mixed Grain or Chop . 1 "	.887	.102	.573	.675	1:5.6
2 "	1.774	.204	1.146	1.350	
3 "	2.661	.306	1.719	2.025	
4 "	3.548	.408	2.292	2.700	
5 "	4.435	.510	2.865	3.375	
6 "	5.322	.612	3.438	4.050	
7 "	6.209	.714	4.011	4.725	
8 "	7.096	.816	4.584	5.400	
9 "	7.983	.918	5.157	6.075	
10 "	8.870	1.020	5.730	6.750	
*Wheat Middlings..... 1 "	.899	.124	.590	.714	1:4.76
2 "	1.798	.248	1.180	1.428	
3 "	2.697	.372	1.180	2.142	
4 "	3.596	.596	2.360	2.856	
5 "	4.495	.620	2.950	3.570	
†Wheat Bran 1 "	.896	.116	.463	.579	1:3.99
2 "	1.792	.232	.926	1.158	
3 "	2.688	.348	1.389	1.737	
4 "	3.584	.464	1.852	2.316	
5 "	4.480	.580	2.315	2.895	
6 "	5.376	.696	2.778	3.474	
7 "	6.272	.812	3.241	4.053	
8 "	7.168	.928	3.704	4.632	
†Low Grade Flour..... 1 "	.889	.090	.600	.690	1:6.67
2 "	1.778	.180	1.200	1.380	
3 "	2.667	.270	1.800	2.070	
4 "	3.556	.360	2.400	2.760	
5 "	4.445	.450	3.000	3.450	

Kind and Amount of Food.	Total Dry Matter.	Pounds of Digestible Nutri- ents.			Nutritive Ratio.
		Protein.	Carbohy- drates+ (Fat X 2.25)	Total.	
*Shorts 1 pound	.906	.117	.614	.731	1:5.25
2 "	1.812	.234	1.228	1.462	
3 "	2.718	.351	1.842	2.193	
4 "	3.624	.468	2.456	2.924	
5 "	4.530	.585	3.070	3.655	
6 "	5.436	.702	3.684	4.386	
7 "	6.342	.819	4.298	5.117	
8 "	7.248	.936	4.912	5.848	
†Beeswing.....1 "	.93	.072	.503	.520	1:6.9
2 "	1.86	.144	1.006	1.040	
3 "	2.79	.216	1.509	1.560	
4 "	3.72	.288	2.012	2.080	
5 "	4.65	.360	2.515	2.600	
6 "	5.58	.432	3.018	3.120	
7 "	6.51	.504	3.521	3.640	
8 "	7.44	.576	4.024	4.160	
9 "	8.37	.648	4.527	4.680	
10 "	9.30	.720	5.030	5.200	
*Cotton Seed Meal 1 "	.94	.390	.448	.838	1:1.15
2 "	1.88	.780	.896	1.676	
3 "	2.82	1.170	1.344	2.514	
4 "	3.76	1.560	1.792	3.352	
5 "	4.70	1.950	2.240	4.190	
6 "	5.64	2.340	2.688	5.028	
*Cotton Seed Hulls 1 "	.902	.006	.265	.271	1:44.16
2 "	1.804	.012	.530	.542	
3 "	2.706	.018	.795	.813	
4 "	3.608	.024	1.060	1.084	
*Oil Cake 1 "	.909	.259	.497	.756	1:1.9
2 "	1.818	.518	.994	1.512	
3 "	2.727	.777	1.491	2.278	
4 "	3.636	1.036	1.988	3.024	
5 "	4.545	1.295	2.485	3.780	
6 "	5.454	1.554	2.962	4.536	
*Gluten Meal.....1 "	.929	.220	.513	.733	1:2.3
2 "	1.858	.440	1.026	1.466	
3 "	2.787	.660	1.539	2.199	
4 "	3.716	.880	2.052	2.932	
5 "	4.645	1.100	2.565	3.665	
6 "	5.574	1.320	3.078	4.398	
7 "	6.503	1.540	3.591	5.131	
8 "	7.432	1.760	4.104	5.864	

Kind and Amount of Food.	Total Dry Matter	Pounds of Digestible Nutri- ents.			Nutritive Ratio
		Protein	Carbohy- drates + (Fat X 2.25)	Total	
*Gluten Feed..... 1 pound	.913	.219	.625	.844	1: 2.8
2 "	1.826	.438	1.250	1.688	
3 "	2.739	.657	1.875	2.532	
4 "	3.652	.876	2.500	3.376	
5 "	4.565	1.095	3.125	4.220	
6 "	5.478	1.314	3.750	5.064	
7 "	6.397	1.533	4.375	5.908	
8 "	7.304	1.752	5.000	6.752	
*Corn Chop 1 "	.902	.063	.783	.846	1: 12.4
2 "	1.804	.126	1.566	1.692	
3 "	2.706	.189	2.349	2.538	
4 "	3.608	.252	3.132	3.384	
5 "	4.510	.315	3.915	4.230	
6 "	5.412	.378	4.398	5.076	
7 "	6.314	.441	5.481	5.922	
8 "	7.216	.504	6.264	6.768	
†Corn Bran..... 1 "	.94	.053	.413	.466	1: 7.8
2 "	1.88	.106	.826	.932	
3 "	2.82	.159	1.239	1.398	
4 "	3.76	.212	1.652	1.864	
5 "	4.70	.265	2.065	2.330	
†Corn Ensilage..... 1 "	.21	.055	.451	.506	1: 8.2
5 "	1.05	.275	2.255	2.530	
12 "	2.52	.660	5.412	6.072	
15 "	3.15	.825	6.765	7.590	
18 "	3.78	.990	8.118	9.108	
20 "	4.20	1.000	9.020	10.120	
†Oat Dust 1 "	.902	.081	.434	.515	1: 5.35
2 "	1.084	.162	.868	1.030	
3 "	2.706	.243	1.302	1.545	
4 "	3.608	.324	1.736	2.060	
5 "	4.510	.405	2.170	2.575	
6 "	5.412	.486	2.604	3.090	
7 "	6.314	.567	3.038	3.605	
8 "	7.216	.648	3.472	4.120	
*Malt Sprouts..... 1 "	.912	.235	.311	.551	1: 1.3
2 "	1.824	.470	.632	1.102	
3 "	2.736	.705	.948	1.653	
4 "	3.648	.940	1.264	2.204	
5 "	4.560	1.175	1.580	2.755	
6 "	5.472	1.310	1.896	2.306	
7 "	6.384	1.645	2.212	3.857	
8 "	7.296	1.880	2.528	4.408	
9 "	8.208	2.115	2.844	4.959	
10 "	9.120	2.350	3.160	5.510	

Kind and Amount of Food.	Total Dry Matter	Pounds of Digestible Nutri- ents.			Nutritive Ratio
		Protein	Carbohy- drates + (Fat X 2.25)	Total	
*Crushed Barley 1 pound	.897	.096	.646	.742	1: 6.73
2 "	1.794	.192	1.292	1.484	
3 "	2.691	.288	1.938	2.226	
4 "	3.588	.384	2.584	2.968	
5 "	4.485	.480	3.230	3.710	
6 "	5.382	.576	3.876	4.452	
†Dried Beet Pulp 1 "	.970	.072	.655	.727	1: 9.09
2 "	1.940	.144	1.310	1.454	
3 "	2.910	.216	1.965	2.181	
4 "	3.880	.288	2.620	2.908	
5 "	4.850	.360	3.275	3.635	
6 "	5.820	.432	3.930	4.362	
7 "	6.790	.504	4.585	5.089	
8 "	7.760	.576	5.240	5.816	
9 "	8.730	.648	5.895	6.543	
10 "	9.700	.720	6.550	7.270	

*Results calculated from American records.

†Digestibility of foods marked thus was determined at this Station. Work along this line is in progress, and we expect soon to have sufficient data for a bulletin dealing more particularly with the question of digestion co-efficients.

Ontario Agricultural College and Experimental Farm.

AN EXPERIMENTAL SHIPMENT OF FRUIT TO WINNIPEG.

BY J. B. REYNOLDS, PROFESSOR OF PHYSICS.

SUMMARY.

1. The Western market demands well-colored and well-matured fruit.
2. Both in appearance and in prices, Ontario peaches, if allowed to mature properly on the tree, compare favorably with California peaches on the Winnipeg market.
3. California and British Columbia, although at a much greater distance than Ontario, are fast getting a monopoly of the Western market.
4. Owing to tariff and higher freight charges, California peaches, in competition with Ontario peaches, suffer a handicap of 40 cents a box.
5. In carload lots, freight rates to Winnipeg, including icing, are little more than one-third express rates. Quickly-ripening fruit is safer in a good refrigerator car for six or eight days than in a hot unventilated express car for three days.
6. Transportation ought to be no hindrance to a large expansion of trade in tender fruits between Ontario and the Northwest. Peaches, plums, grapes, and Bartlett pears, well matured, carried safely with eight days' transit. A transit of five days over the same route is frequently accomplished, and is quite practicable.
7. Our fruit is at a disadvantage in the market because of the general lack of uniformity, neatness, and skill displayed in grading and packing.
8. A uniform size and style of package is very desirable. So far as possible, all box packages should be of the same length and width, and should vary in depth to suit the character of the fruit.
9. So far as rapid cooling and safe shipping in cold storage are concerned, the barrel is suited to winter apples, the bushel box, 10x11x20 inches, to early fall apples and winter pears, and the half bushel 5x11x20 inches, to peaches and early pears.
10. The basket carries grapes and plums satisfactorily, but, for safety, it should be enclosed, as in the Georgia 5-basket carrier, Fig. 4, or the 2-basket carrier, Fig. 8.
11. To remedy existing defects in all departments of the fruit trade, and to put it on a secure footing, the co-operative plan should be adopted, including a central packing house, the employment of expert packers, and an organization capable of overcoming obstacles.

I. PRELIMINARY ARRANGEMENTS.

(1). In the summer of 1903 the writer, after making some extended inquiries into the matter of transportation of fruit under refrigeration, recommended to the Minister of Agriculture an experimental shipment of fruit from Southern Ontario to the Northwest of Canada, with a view to obtaining information on the whole question of the Western fruit trade. The situation with respect to this trade, though it should be full of hope, is as a matter of fact discouraging to the Ontario fruit-grower. On the one hand, as an enticing prospect, there lies the great Northwest, a large, increasing, and ever profitable market. The choice fruits peculiar to Southern Ontario will never be produced in those northern latitudes, and an exchange of Ontario fruits for No. 1 hard wheat seems reasonable and proper. On the other hand, as a discouraging reality, fruits from the Pacific Coast are rapidly pre-empting the Western market, and rarely can Ontario peaches, grapes, and plums be seen displayed in the shop-fronts of Winnipeg. Very little fruit, if any, except apples and pears, is being shipped to the West by freight, and express charges are almost prohibitive. Prominent and well informed fruit growers, who have done some shipping on their own account, upon being consulted on this matter, gave the opinion that, for several reasons, a freight traffic in tender fruits between Ontario and the Northwest was impracticable. The reasons given are, in the main as follows: First, our fruits are not of good shipping quality; secondly, the railroads do not give sufficiently rapid despatch; thirdly, in refrigerator cars, icing is not properly attended to in transit; fourthly, the market, and the means of disposing of the fruit in the West, are uncertain.

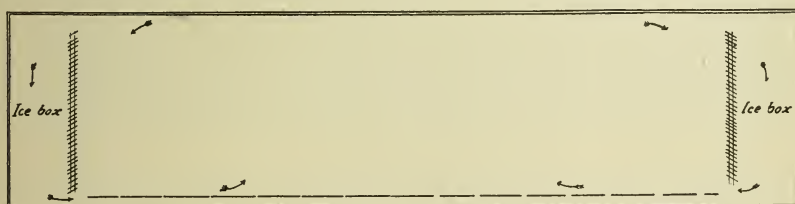
With respect to the first of these objections, namely, the poor shipping quality of our tender fruits, the force of the objection remained to be tested by an actual shipping experiment. In the meantime, storage experiments conducted at the College had demonstrated that Crawford peaches will hold their form and quality for eighteen days at a temperature of 38 degrees; peaches of the Longhurst type will keep sound and firm for thirty-six days, and Washington and Bradshaw plums for twenty days, at the same temperature. It is generally supposed, however, that fruits do not keep so well during shipping as they do in the warehouse, by reason of the injuries incident to transportation. At the same time, careful packing and loading in carload lots not to be rehandled during transit, would, it was believed, reduce to a minimum the damage incurred in shipping.

The remaining objections, namely, those relating to time of transit, icing, and the market, while undoubtedly serious, are not insurmountable, and relate to conditions capable of improvement and correction. It was the aim of the proposed experiment to secure information upon these very points, and to bring such matters as require righting to the attention of authorities competent to deal with them.

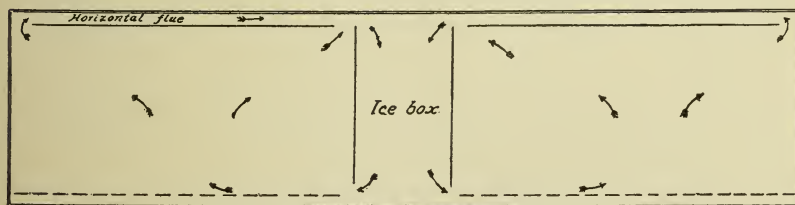
Early in the season of 1904, with the approval of the Minister, active preparations for this shipment were commenced. Much preliminary work had to be covered before the shipment could be undertaken, such as decid-

ing upon and obtaining the packages to be used, interviewing fruit growers and securing promises of contributions to the shipment, instructing them upon the selection and packing of the fruit, and arranging the terms upon which the fruit was to be supplied. Before hand, certain conditions seemed without trial to be essential to success, and these were as far as possible closely adhered to: the fruit selected should be all No. 1 grade, and should be sufficiently mature to be of good quality upon reaching the market; peaches and Bartlett pears should be wrapped singly in paper; closed packages only should be used; the cars should be loaded carefully by nailing each package in place, and by spacing packages so as to allow circulation of air on all sides of a package; by shipping in carload lots the fruit would not be rehandled until it reached the market; and the cars must be kept iced, and as quick transit as possible secured. Crawford peaches formed the staple variety in the shipment, and as many kinds of fruit as were in season at the same time were included. Owing to the lateness of fruit this year, the cars were not shipped until September 14th and 16th respectively.

(2). From St. Catharines was sent a C. P. R. car, Bohn refrigerator system, and from Grimsby a car known as the Hanrahan refrigerator. These two cars differ in their interior construction in four particulars: First, the ice bunkers in the Bohn system are at the ends of the car; in the Hanrahan the ice is in the middle of the car; second, in the Hanrahan, horizontal flues the full width of the car run just below the ceiling from the ice bunkers in both directions to the ends of the car, for the purpose of



Section of C.P.R. car; Bohn refrigerator.



Section of a Hanrahan car.

Fig. 1.

conveying to the bunkers the warm air from the ends remote from the ice and allowing cold air to flow back to these ends; in the Bohn system there is no such flue. Third, the floor of the Hanrahan is provided with a rack, like lattice work, that carries the load off the floor and allows air to flow underneath; the floor of the Bohn system is provided only with slats two inches high and about eight inches apart running lengthwise of the

car. These slats are not suitable for loading boxes. The fourth difference consists in the form of partition between the ice bunker and the car proper. In both cases there are spaces above and below the partition providing for the flow of warm and cold air. But in the Hanrahan the partition, with the exception of these spaces, is solid, and thus gives definite direction to the air currents. In the Bohn system the partition is formed of galvanized iron slats, placed like the slats in a window shutter. Sections of the cars are shown in Fig. 1, and illustrate these differences.

It was expected that a transit of six or eight days with plums and Crawford peaches would indicate any difference in efficiency between these cars. It is claimed that some refrigerator cars fail to maintain a uniform temperature throughout the car—the top of the car and the parts most remote from the ice, being, it is claimed, several degrees higher in temperature than the bottom near the ice. This difference of temperature would of course be most pronounced in hot weather, and in cool weather would be small. It so happened that the weather during this shipment was quite cool. Whether or not this fact accounts for the uniformity in results cannot be asserted, but at all events there was no noticeable difference in the condition of the fruit upon arrival at Winnipeg. As a test of efficiency in the cars, therefore, the experiment is inconclusive, and must be repeated in warmer weather or over greater distances, before any decisive report can be given out upon this matter.

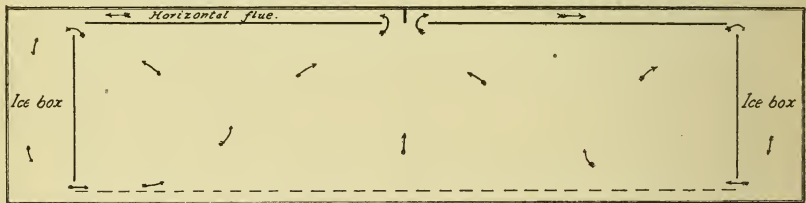


Fig. 2—Section of car showing interior construction for air circulation with bunkers at end. The solid partition next to the ice and the horizontal flue overhead will, it is believed, improve the efficiency of refrigerator cars.

To maintain uniformity of temperature throughout a refrigerator it has been already demonstrated beyond question that a regular circulation of air through the whole system, including refrigerator and ice-house, is necessary. To secure circulation the construction of the refrigerator must be such as to give direction to the air. In principle, and in practice where the test is sufficiently severe, the Bohn system may be improved by adopting the essential parts of the Hanrahan system where this relates to air circulation; that is, a solid instead of a slatted partition, and a flue overhead, (Fig. 2).

II. OBSERVATIONS AT THE SHIPPING POINT.

BY PROF. H. L. HUTT, HORTICULTURIST, ONTARIO AGRICULTURAL COLLEGE.

(1) THE FRUIT. Among the objects of this shipment, one was to place on the Winnipeg market some of the choicest fruit that Ontario could produce, in the hope of helping to open a trade for Ontario growers in the great Northwest.

The accompanying tables give in a condensed form most of the particulars regarding the class, variety, grade, and condition of the fruit shipped. While much of the fruit in each car was first-class, or graded XXX, some of it, as the records show, fell much below that grade, and certainly would not have been shipped if sufficient first-class fruit had been obtainable at the time. The growers were handicapped in this respect to some extent by the unusual lateness of the season, and also by the light crop of some classes of fruit, particularly of the peaches and plums, which we were especially desirous of including in the shipment.

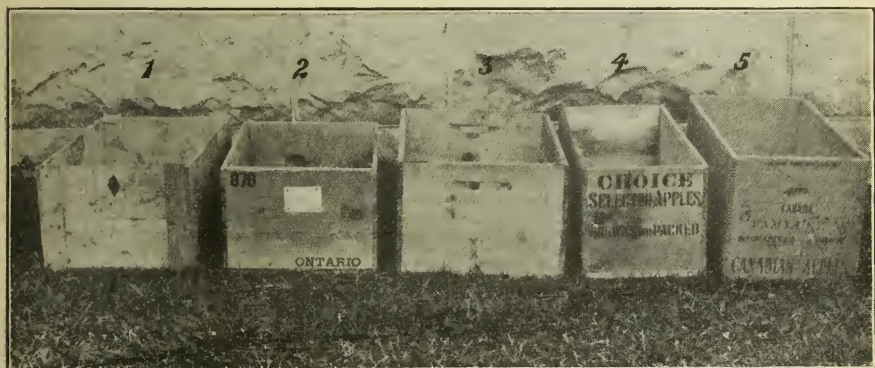


Fig. 3.—Some Ontario Apple Boxes:

1. Dimensions, 9 in. x $12\frac{1}{2}$ in. x 19 in.; capacity, 2137 cubic inches.
2. Dimensions, 9 in. x 13 in. x 18 in.; capacity, 2106 cubic inches.
3. Dimensions, $9\frac{3}{4}$ in. x 14 in. x $20\frac{1}{4}$ in.; capacity, 2764 cubic inches.
4. Dimensions, 10 in. x 10 in. x $22\frac{1}{4}$ in.; capacity, 2225 cubic inches.
5. Dimensions, 11 in. x $11\frac{1}{4}$ in. x $22\frac{1}{2}$ in.; capacity, 2784 cubic inches.

The standard size (not shown), 10 in. x 11 in. x 20 in.; capacity, 2200 cubic inches.

Another reason that much of the fruit was not of a kind to tempt the buyer was because it was picked too green. A general impression seemed to be in the minds of many of the shippers that none but green, hard fruit, particularly of peaches, plums, and pears, would carry safely to the Winnipeg market. This was, of course, a point upon which no reliable information was at hand, and one of the valuable lessons afforded by this experiment is that our finer fruit, such as peaches, plums, and pears, should at the time of shipment be well matured, well colored, and not too firm to be quite ripe, or at least mellow, by the time it is placed on the market.

The peaches in these shipments that were hard and firm when shipped reached the Winnipeg market without any perceptible change, while those

that were matured enough to be semi-firm when shipped were in the best condition to attract buyers when placed on the market at Winnipeg.

One box of first-class peaches, which at the point of shipment had been recorded as "semi-firm and probably too ripe for shipment" was traced to the consumer and a special report was obtained on it. This box was packed on September 15th, loaded September 16th, and sold at Winnipeg on September 23rd. On September 26th the buyer reported that "a few of the peaches were then mellow enough to use, and by the end of the week the whole of the box would probably be sufficiently ripe."

This may seem an exceptional case, and there is no doubt that the cool weather at Winnipeg after the arrival of the shipment aided in the keeping of the fruit. Still it establishes the fact that if our finest peaches are allowed to attain full size and color before picking, and are then cooled down quickly and kept cool, they can be shipped or held at least two weeks and be in prime condition for use.

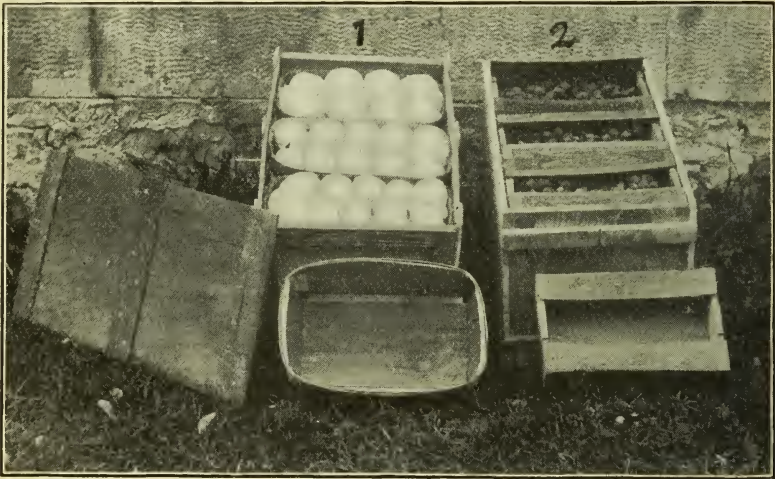


Fig. 4.—(1) The Georgia carrier for peaches or plums. (2) The standard apple box fitted with trays for grapes.

(2) PACKAGES. Owing to the fact that there are so many kinds of packages in use for the different kinds of fruit, and that the fruit was supplied by a number of growers, there was no uniformity in the size and shape of the packages used in these shipments. For several reasons this was a decided disadvantage. They could not be packed to advantage in the car; when placed on the market they presented a motley and unattractive appearance; buyers were at a loss to know which shape of package was really the best value for the money. All this could not but injure to some extent the sale of the fruit.

It was thought best, for these shipments, to adopt the box or crate package rather than the barrel or basket. No barrels or baskets were sent except a few baskets of grapes from St. Catharines, which were placed

on top after all the boxes had been loaded in the car, in which position they carried all right. It is doubtful, however, if the basket is sufficiently strong to stand the pressure when loaded from the bottom to top of the car.

For the apples, the box used was 10x11x20 inches, the size adopted as the standard by the Ontario Fruit Growers' Association. This makes a convenient shaped box for packing and handling, and if it is to be the standard size, the sooner all shippers fall in line and make use of it, the better it will be for the trade.

For the pears three different shapes of boxes were used in one car; one 5x11x20 inches, another 5x10x22½ inches, and still another 5x12x18½ inches. It can readily be understood how awkward these various sizes were to pack together in a car. The first had been adopted as the standard pear box and is just half the size of the standard apple box.

To secure uniformity in the peach packages, boxes 5x12x18½ inches, the same size as the California peach case, were furnished to those who had agreed to ship peaches. This may be a convenient size for packing peaches and pears, but a more convenient size for shipping in mixed car lots would be the standard pear box.

The grapes were shipped in the standard apple box, fitted with twelve cardboard trays, having wooden ends, each tray holding about 2½ pounds of fruit, as shown to the right in Fig. 4. This makes a very safe and convenient package, and apparently was an acceptable one in the Winnipeg market, no doubt because it rendered convenient the retailing of the fruit in small quantities. This case, however, at the present price, 30 cents, is altogether too expensive. A case after the style of the Georgia peach carrier, as shown to the left in Fig. 4, is one well worthy of adoption by our growers. This case has been adopted almost entirely for the Georgia peach trade, and is looked upon by the fruit experts at the Department of Agriculture at Washington as the best case in use for peaches, plums, and grapes. This case complete, with the six 4-quart baskets, as shown, can be purchased F.O.B. Georgia at 12½ cents. Surely our manufacturers could put up such a case for at least 15 cents.

Apart from the desirability of adopting a uniform style of package, there are two other respects in which the general appearance of our packages might be improved. The lumber of which they are made should be neatly dressed, and the branding should be more uniform and neatly done. Professor Reynolds, who accompanied these cars to Winnipeg, had an opportunity of comparing our packages with those in California shipments, which arrived while he was there. In this respect he says: "The general appearance of our boxes leaves much to be desired. They are rough and unfinished. Dressing the outside of the lumber of which they are made would cost only a trifle more, and would add much to their general appearance, besides making any printing, stamping, or writing more legible." With regard to the branding he says: "The designations of the boxes, the packer's name, the variety and grade are not made sufficiently distinct, and the styles of branding are anything but uniform. The result is that it is often difficult to make out the names of the shippers or the variety or grade of the fruit; and when viewed as a whole on the market, they presented a motley and unattractive appearance."

(3) GRADING AND PACKING. The car from St. Catharines was filled with apples, pears, peaches, plums, and grapes, the fruit being furnished by eighteen of the growers of that locality. Dominion Fruit Inspector Carey and I examined carefully a number of cases of each class of fruit put up by each shipper. A large number of the growers were present, and the one fault which was evident to all was the great lack of uniformity in grading, packing and branding. Evidently no two shippers seemed to have the same idea as to what constituted No. 1 or No. 2 grade of fruit. Some of the growers sent in first-class fruit packed in first-class style, but others sent in ungraded fruit, improperly packed and wrongly branded. From my personal acquaintance with many of the shippers concerned, I feel certain that none of them would intentionally do wrong in this matter; yet the fact remains that in a trial shipment made with the object of open-



Fig. 5.—First-class peaches and pears, carefully graded and neatly packed.

ing up a new market, fruit was being sent which, because of the grading and packing, could not but bring discredit upon the shipper whose name appeared on every case, and could not but tend to close the market against even those who were doing all right, but happened to be in bad company. To avoid as much as possible such a result, we found it necessary in some cases to rebrand the fruit to a lower grade.

It so happened that there was present at the time of the shipment Mr. Carson, a Canadian, who was a few years ago engaged in fruit growing in the Georgian Bay district. He was an interested spectator, because he is now engaged in shipping California fruit to the Northwest market. He told us frankly that he had no fear of competition from Ontario so long as our fruit was sent in such condition, and, for the benefit

of those present, a demonstration was given as to how the California fruit is graded and packed for shipment.

A few cases picked at random from Mr. W. H. Bunting's consignment were opened and exhibited as samples which might be depended upon to create a demand in whatever market they might be placed.

The majority of the shippers present were keen to learn and thankful for the suggestions given. One stated that the information gained from the object lesson afforded in grading and packing was well worth all the effort in getting up such a shipment.

From Grimsby the same kinds of fruit were sent, but the carload was made up by only six shippers; consequently, where there were fewer shippers each putting up from one to two hundred cases of his own, there was much more uniformity in packing; yet, even here, we found fruit packed in such a way that it could not but injure the reputation for Ontario fruit on whatever market it might be placed. It was plainly evident to those who examined the fruit that Ontario fruit-growers will have to bestir themselves if they ever expect to compete with California and British Columbia, which now have practically a monopoly on the Northwest market.

(4) CO-OPERATION ESSENTIAL. The greatest need in this part of the business is more uniformity in grading and packing, and vigilant care that none but first-class fruit be offered for sale under a XXX brand. It appears to me that we will never satisfactorily meet these requirements so long as each grower is working alone and independent of his neighbor. What is necessary is, that in each fruit section the growers unite to form a strong co-operative association, that a good energetic man be selected as manager, and that experts be employed to grade and pack the fruit. This would probably necessitate the building of a central packing-house, and involve some expense, but the advantages to be gained would well repay for the outlay. Baskets, boxes and barrels could be purchased wholesale to better advantage; the grower could devote his whole attention to gathering the crop when in proper condition; the association would relieve him of all care and responsibility in grading, packing and marketing; and with this work in the hands of expert packers, the grade would be uniform, the packing carefully and properly done, and with a good business manager in close touch with the markets, the fruit could be marketed when and where it was most in demand. This in the end would result in increased demand on the part of the consumer and increased profits on the part of the producer.

III. TRANSPORTATION.

(1) **LOADING THE CAR.** In loading a refrigerator car with boxes of fruit, there are two conditions to be kept in view; a rigid structure, and provision for circulation of air on all sides of the boxes.

The plan in detail is illustrated in Fig. 6, which shows a number of boxes in position in the car. A row of boxes of the same length and depth was placed side by side, with ends butting against the end of the car, and separated from one another and from the sides of the car by narrow spaces. Across each end of the row a slat was laid, nailed to each box,

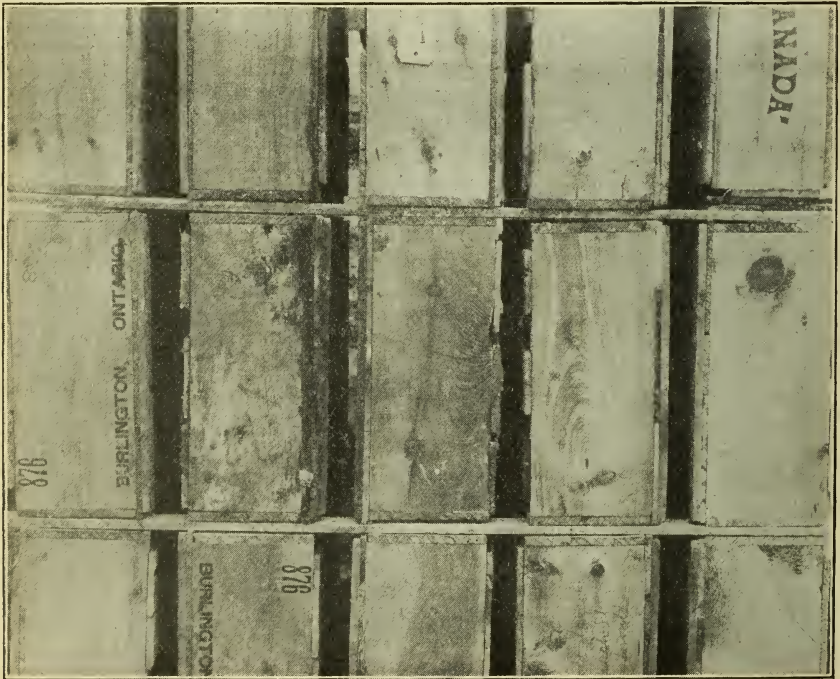


Fig. 6.

and butting against the sides of the car. This was repeated until a tier was formed as high as it was desired to go. Then another tier was built in exactly the same way, butting against the first tier, and so on from each end of the car, until it was filled. If any space remains over at the middle, too narrow for a tier of boxes, the load may be braced by scantling.

(2) **RATE OF DESPATCH.** G. T. R. The St. Catharines car left that point about 6 p.m. on September 14th, and arrived at North Bay about 7 p.m. on September 16th, having accomplished a distance of 300 miles in 49 hours, at the average rate of six miles an hour. The second car left

Grimsby at about the same time of the day on September 16th and reached North Bay at about 3 p.m. on September 18th, at about the same rate of despatch. Upon his return from the West, the writer communicated these facts to the Grand Trunk Division Freight Agent, and received the following reply:

DEAR SIR,—Your favor of the 8th inst. was received on my return to the city this morning.

I am sorry that there has apparently been some delay to your shipments of fruit from the Niagara District to the Northwest, in so far as our transportation service from shipping points to North Bay is concerned. I am taking matter up with our Car Service Agent with a view of seeing if a more satisfactory schedule can be arranged, and will advise you as soon as I receive his reply.

Yours truly,

C. E. DEWEY.

C. P. R. The first car left North Bay at 2 p.m. on Saturday the 17th, having been held over from the preceding evening to take the fast freight. This through freight leaving North Bay daily at 2 p.m. is due at Fort William at 4.30 a.m. on the second day following; the train to which the first car was attached was due at Fort William on Monday morning at 4.30. Having seen the first car out at North Bay on Saturday afternoon, and made all arrangements with the trainmaster and the yardmaster for proper attention to the second car upon its arrival, the writer proceeded on Saturday evening to Fort William, and reached there on the following evening. The next morning (Monday), the first car being due, inquiries elicited the fact that it had not arrived. Upon request, the chief despatcher traced the car, found that it had been laid over at White River for repairs, as the report said, and that it would arrive at Fort William that evening by the way freight. As to despatch from Fort William to Winnipeg, the fast freight leaves Fort William daily at 5.30 a.m., and arrives at Winnipeg the next morning at 7.40. There is, however, a way freight that leaves Fort William in the evening, reaching Winnipeg some time the following night, and the yardmaster was requested to see that this car left by that train. The request was not attended to, and instead, the car was sent out by the through freight next morning, and reached Winnipeg Wednesday morning about 9 o'clock. From the freight yards the car was next to be placed at the siding of the Ottawa Fruit and Produce Exchange on Princess Street. There is a Winnipeg by-law that forbids the shunting of cars on sidings between the hours of 7 a.m. and 12 p.m. Hence, by the failure to send the car out from Fort William by the evening train as requested, a delay occurred of 24 hours in the placing of the car.

Now, mark the case in brief. The schedule rate of despatch by fast freight from North Bay to Winnipeg is 16 miles an hour. Provided the Grand Trunk would give the same service, the time from St. Catharines to North Bay would be 19 hours instead of 49. Provided, further, that connection is made at North Bay with the west-bound through freight, and the time from St. Catharines, Grimsby, and other fruit sections ar-

ranged accordingly, we should have, with the existing C. P. R. service, the following schedule, taking specific days and places for clearness :

St. Catharines to North Bay, 1 p.m. Friday to 10 a.m. Saturday; North Bay to Fort William, 2 p.m. Saturday to 4.30 a.m. Monday; Fort William to Winnipeg, 5.30 a.m. Monday to 7.40 a.m. Tuesday. To be unloaded and delivered on trucks, or placed on siding Wednesday morning. This would give a service of four or five days, instead of seven to eight days, as with the two experimental cars, and often longer as with ordinary shipments. Such a schedule as the above is perfectly feasible, and would require over the Grand Trunk portion of the line the establishment of a reasonably prompt through freight, and over the Canadian Pacific only the use of existing schedules.

The history of the second car was similar. It left North Bay on the afternoon of September 18, and according to schedule should have reached Winnipeg on the morning of the 21st. It reached its destination sometime on the 22nd, and was finally placed for unloading on the 23rd, seven days after loading.

These facts are reported not in any spirit of complaint, but simply to place upon record the conditions that surround freight traffic to the Northwest. It is quite obvious that over such an immense stretch of road, and with so large a volume of business as these companies control, accidents and delays occur that are unavoidable. It is, however, within the limits of reasonable expectation that a five day service for tender fruits be arranged from Southern Ontario to Winnipeg.

A report of these facts was sent to the Assistant Freight Traffic Manager of the C. P. R. and it elicited the following reply :

DEAR SIR,—I am in receipt of your favor of the 8th, and am glad to learn the shipment of fruit to Winnipeg under your supervision proved a success.

In answer to your remarks regarding refrigeration, I would say it is expected and required that shippers will fully ice the cars at the point of shipment. If they instruct that the cars are to be re-iced in transit we will undertake to do this at each inspection and icing station, a list of which I gave you, and where necessary the bunkers will be replenished with ice. You will understand, of course, that varying weather conditions have a marked effect upon the ice in the cars, and it is very desirable that even though the temperature may be cool at the time of shipment the shippers should see a full supply of ice is put in the cars, because a change might take place before the next icing station is reached, and unless the bunkers are full, the ice may have disappeared before we have had an opportunity of inspecting or re-icing.

With regard to the time in transit. So far as our line is concerned from North Bay to Winnipeg, there is no reason, barring accident, why we cannot keep our schedule in the handling of fruit cars. You will understand, however, in a haul of such a length interruption may occur from time to time from causes over which we have no control. Fruit and other perishable freight is invariably handled on our line under red cards, and is followed by telegraph through each divisional point by our Superintendent of Car Service to insure despatch. We could not undertake to guarantee the time in transit. We will undertake, however, so far as we can, to see that fruit is given the best possible despatch at the time of handling. Your suggestion that we might run a special service once a week or oftener has already been found to be impracticable. We endeavored to establish such a service on a previous occasion, but found we could not induce the shippers to guarantee a sufficient number of cars to enable us to carry it out. In fact the dealers seemed to be disinclined to

ship at the same time, and I believe there is also objection to their goods reaching the market at the same time, causing an overstock and sometimes a falling in prices.

I may say I am forwarding your letter to our Freight Traffic Manager, and will ask him to communicate the contents to the Superintendent of Car Service and our Superintendent of Transportation. I am sure both these gentlemen will do everything in their power to assist in the shipment of fruit from Ontario points to the west.

Yours truly,

W. B. BULLING.

(3) ICING. This particular, though deserving separate mention, will be briefly dealt with. The second car, from Grimsby, arrived at North Bay, according to the report received, with bunkers only one-fourth full of ice, and three tons of ice were added at that point. The amount added to the first car at North Bay was about one ton and three-quarters. There being no icing station at Grimsby, when the second car left there special instructions were given for re-icing at Hamilton. This probably was not done, and the car having been iced at Hamilton before loading on Wednesday, was not re-iced until it reached North Bay on Sunday. Excepting this omission, the icing was well attended to all along the line. The first car on reaching North Bay was about two-thirds full, and was filled there. When it reached Fort William it was full of ice, having probably been iced at Schreiber. No data were obtained with respect to the total amount of ice consumed, nor would such data be of much value by reason of the infinite variety of weather conditions that surround different shipments.

Under this head the attention of the reader is directed to the remarks on icing in the letter quoted just above.

(4) CHARGES. News was received at St. Catharines, before the first car was sent out, respecting the reduction of freight rates from 84 cents to 66 cents per hundred for mixed fruit. It is likely that our cars were the first to benefit by the more favorable rates. The change made a difference of \$36 on each carload, 9 cents on a bushel of apples, and nearly 4 cents on a box of peaches.

The new rates for icing not having been fixed when the transportation charges were sent in, a flat rate of \$16 was charged, which brought the total charge up to 74 cents a hundred for a carload of 20,000 pounds.

Before plans for the experiment were completed, the authorities of the Dominion Express Company were interviewed with a view to shipping an express load on one of the Company's patent ventilated cars. A request was made for a quotation of rates on carload lots from St. Catharines to Winnipeg. The Dominion Express Company not having rail connection at St. Catharines, the quotation was to include the Canadian Express charge from St. Catharines to the point where the Dominion Express would take charge of the car. After consideration, the company offered to carry the car, upon payment of the local rate of the Canadian Express Company, 30 cents a hundred, and a further charge of \$2.25 a hundred for the portion of the line over which the Dominion Express ran, making a total of \$2.55 a hundred. To this an alternative was offered by the company, namely to ship the fruit by electric line to Port Dalhousie, tranship to boat for car-

riage to Toronto and tranship again to the company's car at Toronto. This involved handling four times instead of twice, and loading twice by the company's agents. Success in shipping to the West requires as little handling as possible and careful loading, hence the alternative as well as the original offer, was dismissed as impracticable.

A comparison of express rates per ordinary car, namely \$2.10 a hundred, with freight rates, 74 cents, gives the following figures, for tender fruits:

	Express.	Freight.
Peaches, per box of 20 pounds.....	42. cents.	14.8 cents.
Pears, per box of 25 pounds.....	52.5 cents.	18.5 cents.
Plums, per box of 25 pounds.....	52.5 cents.	18.5 cents.
Grapes, per basket (6—100 pounds).....	35 cents.	12.3 cents.

An express car loaded at Grimsby could be placed and sold at Winnipeg three days after. But tender fruits well-selected, well-packed, and well-loaded would be safer in a refrigerator car for six days or eight days than in a hot, unventilated express car for three days. Our experiment has proved that tender fruits can be carried by freight with safety; and as to rates, the total freight charges are a little more than one-third of the express rates.

IV. OBSERVATIONS ON THE MARKET IN WINNIPEG.

(1) THE PRICES OBTAINED, AND CONDITION OF FRUIT. The following tables present in concise form information respecting the grade, quality and condition of the fruit, and the prices obtained. The column under "Net Proceeds" gives the returns to the grower after deducting charges for freight, commission, and cost of package, but not for packing and wrapping.

Peaches: The package used contains, in peaches wrapped in manila paper and tightly packed, slightly more than the 11-quart basket of bare peaches, about 13 quarts. Crawford peaches, XXX, realized from 85 to 90 cents net; Crawford XX, 70 to 80; Elbertas, 62½ to 80.

These prices compare very favorably with those obtained locally in Ontario this year, and Ontario prices this year are unusually high, while at Winnipeg prices are no higher than usual.

The peaches sold entirely on their appearance and quality, with no reputation to help them. It is very gratifying to note that the prices were fully equal to those for the best California peaches on the same dates. The greater size of the California fruit was quite counterbalanced by the superior brightness and color of our fruit.

With respect to competition of Ontario peaches with the Western product, it should be borne in mind that the latter suffers a serious handicap in the matter of charges. Against a freight charge of 15 cents on a box of peaches from Southern Ontario to Winnipeg, there is a freight charge of 36 cents from California, and in addition a duty of 19 cents, making a total of 55 cents—a handicap of 40 cents a box. In a letter addressed to a Winnipeg commission firm, the writer saw quoted 50 cents

a box F.O.B. California. To compete with these California prices, peaches might be quoted 90 cents a box F.O.B. St. Catharines or Grimsby. In fact, with one exception, prime Crawford peaches sold in advance of this price, and the average net price obtained for No. 1 Crawfords, counting the price of the box, was 92 cents.

Package,—4 $\frac{3}{4}$ in. x 12 in. x 18 $\frac{1}{2}$ in ; cost, 8c.

ST. CATHARINES.

Shipper.	Variety.	Quantity.	Grade.	Quality.	Maturity.	Packing.	Condition at market.	Price.	Charges.	Net proceeds.
C. E. Secord.....	Crawford....	4	XXX	good.....	semi-firm	tight....	ripe.....	1.25	35 $\frac{1}{2}$	89 $\frac{1}{2}$
W. H. Bunting....	Crawford....	5	XXX	good.....	semi-firm	tight....	ripe.....	1.20	35	85
A. C. Gregory....	Crawford....	21	XXX	fair.....	firm.....	tight....	firm.....	1.20	35	85
W. H. Secord....	Crawford....	5	XX	fair.....	semi-firm	.....	ripe.....	1.15	34 $\frac{1}{2}$	80 $\frac{1}{2}$
Robt. Thompson..	Crawford....	10	XX	fair.....	hard.....	.....	firm.....	1.13	34	79
J. Burdy.....	Crawford....	10	XX	medium..	firm.....	.....	firm.....	1.05	33 $\frac{1}{2}$	71 $\frac{1}{2}$
C. E. Secord.....	Elberta....	1	XXX	fair.....	firm.....	.....	firm.....	1.15	34 $\frac{1}{2}$	80 $\frac{1}{2}$
J. H. Brodrick....	Elberta....	10	XX	fair.....	hard.....	tight....	hard.....	1.05	33 $\frac{1}{2}$	71 $\frac{1}{2}$
F. A. Goring.....	Elberta....	10	XXX	fair.....	hard.....	tight....	hard.....	.95	32 $\frac{1}{2}$	62 $\frac{1}{2}$

GRIMSBY.

W. J. Drope.....	Crawford....	3	XXX	good.....	firm.....	tight....	firm.....	1.25	35 $\frac{1}{2}$	89 $\frac{1}{2}$
S. Cockburn.....	Crawford....	9	XXX	good.....	semi-firm	tight....	ripe.....	1.22	35	87
J. F. Brennan....	Crawford....	3	XXX	good.....	semi-firm	tight....	ripe.....	1.20	35	85
	Crawford....	47	XXX	good.....	firm.....	tight....	firm.....	1.20	35	85
E. M. Smith.....	Crawford....	12	XXX	good.....	firm.....	tight....	firm.....	1.08	34	74

The low price on the last lot—74c. net— was due, not to any inferiority in the fruit, but simply to the uncertainty in the method of sale.



Fig. 7 shows two boxes of Ontario peaches with a box of California peaches between. It may be seen that the California fruit is larger; but in other particulars the Ontario fruit is superior. The photograph does not do justice to the fine colors of the Ontario fruit. A close inspection, however, will reveal these colors. The California box of fruit is uniformly pale, while the Ontario specimens show dark and pale alternately. The dark is, of course, the colored side of the peach, and the fine appearance of the original, as contrasted with the paleness of the California product, is at once evident.

Plums: The dealers at Winnipeg seemed somewhat timid in purchasing the plums, and did not offer high prices, although the fruit was in good condition. In terms of the 11-quart basket, the Reine Claude plums netted 47 cents, the Yellow Egg 54 cents, and the Grand Duke and Glass 48 cents. These prices are of course much below Ontario prices this year, and would not be considered high at any time.

Package,—12-tray crate, 10 in. x 11 in. x 21 in. ; 27 pounds of fruit.

ST. CATHARINES.

Shipper,	Variety.	Quantity.	Grade.	Quality.	Maturity.	Condition at market.	Price.	Charges.	Net proceeds.
W. H. Secord.....	R. Claude....	5	XXX	good.....	firm.....	sound semi-firm	1.50	75	75

Package,—2-basket crate ; 20 pounds of fruit.

GRIMSBY.

E. M. Smith.	Y. Egg.....	48	XXX	good.....	firm.....	soft.	1.08	43	65
.....	G. Duke.	25	XXX	good.....	firm.....	semi-firm	1.00	42	58
.....	Glass	17	XXX	good.....	firm.....	semi-firm	1.00	42	58



Fig. 8 shows the 2-basket-crate, and the condition of the plums at Winnipeg. The basket at the left contains Yellow Egg, the other Grand Duke. The spotted appearance of the latter is due to the partial bloom remaining on the fruit. These plums are shown just as they were opened up, and, as may be seen, are quite sound.

Grapes: With the exception of one lot of Moore's Early, of which a large percentage were off the stem, and which netted 66 cents, and one crate of Concord, which netted 70 cents, the grapes realized prices ranging from 75 cents to \$1.02 per crate of 30 pounds. After deducting all charges and cost of packing, 40 to 50 cents a basket would be very nearly the equivalent of these prices. Had it not been for the excessive cost of the crate used—30 cents—the results would have been even more satisfactory.

Package, —Crate, 10 in. x 11 in. x 21 in., 12 trays; cost, 30c.

ST. CATHARINES.

Shipper.	Variety.	Quantity.	Grade.	Quality.	Maturity.	Condition at market.	Price.	Charges.	Net proceeds.
J. R. Secord.....	Niagara.....	2	XXX	good.....	ripe.....	sound.....	1.80	78	1.02
J. H. Brodriek.....	Wy. Red.....	3	XXX	good.....	firm.....	sound.....	1.75	77½	97½
W. H. Nicholson.....	M. Early.....	6	XXX	good.....	ripe.....	sound.....	1.65	76½	85½
F. G. Stewart.....	M. Early.....	20	XXX	good.....	ripe.....	sound.....	1.65	76½	88½
J. H. Brodriek.....	Worden.....	4	XXX	good.....	ripe.....	sound.....	1.60	76	84
J. R. Secord.....	Worden.....	2	XXX	good.....	ripe.....	sound.....	1.60	76	84
W. H. Secord.....	M. Early.....	2	XXX	good.....	ripe.....	sound.....	1.60	76	84
C. E. Secord.....	M. Early.....	10	XXX	good.....	off stem.....	sound.....	1.52	75	77
J. H. Brodriek.....	M. Early.....	8	XXX	good.....	sound.....	sound.....	1.50	75	75
W. H. Secord.....	Concord.....	1	XXX	good.....	firm.....	sound.....	1.45	74½	70½
F. A. Goring.....	M. Early.....	10	XXX	good.....	ripe.....	off stem.....	1.40	74	66

Pears: Packages,—5 in x 10 in. x 22½ in.; 5 in. x 11 in. x 20 in.;
5 in. x 12 in. x 18½ in.; cost, 8-10c.

GRIMSBY.

Shipper.	Variety.	Quantity.	Grade.	Quality.	Maturity.	Packing.	Condition at market.	Price.	Charges.	Net proceeds.
L. Woolverton.....	Bartlett.....	21	exXXX	good.....	semi-firm	slack.....	ripe.....	1.05	39½	65½
.....	Bartlett.....	76	XXX	good.....	semi-firm	slack.....	ripe.....	.70	36	34
.....	Bartlett.....	111	XX	good.....	firm.....	slack.....	firm.....	.60	35	25
.....	Bartlett.....	94	X	fair.....	firm.....	slack.....	firm.....	.55	34½	20½
S. Cockburn.....	Bartlett.....	15	XXX	good.....	firm.....	.....	firm.....	.70	34	36
S. F. Brennan.....	Bartlett.....	10	XXX	good.....	firm.....	squeezed.	firm.....	.68	34	34
A. H. Pettit.....	Bartlett.....	7	XXX	good.....	firm.....	tight.....	firm.....	.60	33	27
W. Walker.....	Bartlett.....	10	XX	good.....	firm.....	.....	firm.....	.55	32½	22½
J. F. Brennan.....	F. Beauty.....	21	XXX	fair.....	firm.....	squeezed.	firm.....	.60	33	27
.....	F. Beauty.....	14	XX	fair.....	firm.....	squeezed.	firm.....	.60	33	27
M. Pettit.....	F. Beauty.....	100	XXX	fair.....	hard.....	tight.....	hard.....	.58	35	23

Package,—5 in. x 10 in. x 22½ in.; cost, 10c.

ST. CATHARINES.

H. S. Cole.....	Bartlett.....	7	XX	good.....	firm.....	tight.....	firm.....	1.25	41½	83½
F. Blaikie.....	Bartlett.....	24	XXX	good.....	semi-firm	.....	ripe.....	1.13	40	73
J. H. Brodriek.....	Bartlett.....	11	XX	fair.....	firm.....	slack.....	firm.....	1.10	40	70
J. Burdy.....	Bartlett.....	5	XXX	medium.....	firm.....	.....	firm.....	1.10	40	70
Titterington & Co.....	Bartlett.....	5	XXX	good.....	firm.....	tight.....	firm.....	1.10	40	70
R. F. Robinson.....	Bartlett.....	20	XXX	good.....	semi-firm	tight.....	ripe.....	1.01	39	62
Robt. Thompson.....	Bartlett.....	14	XXX	good.....	semi-firm	tight.....	ripe.....	1.00	39	61
A. C. Gregory.....	Bartlett.....	20	XX	fair.....	semi-firm	slack.....	ripe.....	.99	39	60
J. H. Brodriek.....	Seckel.....	4	XX	fair.....	hard.....	tight.....	hard.....	1.00	39	61
.....	Clairgeau.....	8	XX	fair.....	hard.....	slack.....	hard.....	.95	38½	56½

For the sake of comparison, four lots of pears from one orchard, graded Extra XXX, XXX, XX, and X, are placed together. The Flemish Beauty lots, while good stock, were altogether too immature, and, as the prices show, were not wanted.

The pears shipped by H. S. Cole were marked XX on account of being ungraded and having a few small ones in each box. They were all of good quality and for the most part large enough for XXX.



Fig. 9 shows XXX Bartlett pears at Winnipeg. For the photograph, the wrapping was removed and the pears rearranged.

Apples: Package,—10 in. x 10 $\frac{3}{4}$ in. x 21 in.; cost, 14c.
ST. CATHARINES.

Shipper.	Variety.	Quantity.	Grade.	Quality.	Maturity.	Packing.	Condition at market.	Price.	Charges.	Net proceeds.
W. H. Bunting	St. Lawrence	13	XXX	good.....	ripe.....	tight .....	.....	1.16	63	53
Titterton & Co..	Gravenstein..	21	XXX	good.....	ripe.....	tight .....	.....	1.08	62	46
J. R. Secord	B. Pippin....	5	XXX	fair.....	firm.....	.....	.....	1.05	61 $\frac{1}{2}$	43 $\frac{1}{2}$
W. H. Bunting	Cayuga	29	XXX	fair.....	firm.....	tight .....	.....	1.03	61	42
H. S. Cole	Cayuga	10	XX	good.....	firm.....	slack .....	.....	1.03	61	42
C. E. Secord	Gravenstein..	24	XXX	good.....	firm.....	tight .....	.....	1.00	61	39
.....	H. Pippin....	13	XXX	good.....	.....	.....	.....	1.00	61	39
.....	F. Pippin....	25	XXX	good.....	.....	.....	.....	1.00	61	39
Robt. Thompson ..	Gravenstein..	28	XXX	fair.....	firm.....	slack .....	.....	.98	61	37
W. H. Bunting	St. Lawrence	11	XX	fair.....	firm.....	tight .....	.....	.94	60	34
A. C. Gregory	Colvert	13	XXX	fair.....	firm.....	slack .....	.....	.93	60	33
J. H. Brodrick.....	Wealthy	1	XXX	good.....	ripe	slack .....	.....	.90	60	30
.....	Ind. Rareripe	16	XX	fair.....	firm.....	slack .....	.....	.85	59 $\frac{1}{2}$	25 $\frac{1}{2}$
W. H. Nicholson ..	Gravenstein..	16	XX	fair.....	firm.....	tight .....	.....	.85	59 $\frac{1}{2}$	25 $\frac{1}{2}$
C. E. Secord	Gravenstein..	4	XX	fair.....	firm.....	tight .....	.....	.84	59	25
A. C. Gregory	R. Pippin....	6	XX	good.....	firm.....	slack .....	.....	.82	59	23
J. H. Brodrick	Kes. Codling.	6	XXX	fair.....	firm.....	slack .....	.....	.75	58 $\frac{1}{2}$	16 $\frac{1}{2}$
.....	Crab.....	$\frac{1}{2}$ bu	XXX	good.....	.....	tight .....	.....	1.05	61 $\frac{1}{2}$	43 $\frac{1}{2}$

The Cayugas shipped by H. S. Cole were ungraded and, therefore, marked by the inspectors XX, although mostly XXX stock.

Package,—10 in. x 10¾ in. x 21 in.; cost, 14c.

GRIMSBY.

L. Woolverton	Wealthy	3	XXX	good	.....	.....	1.13	62	51
A. H. Pettit	Gravenstein	5	XXX	good	.....	firm	1.10	62	48
	Alexander	5	XXX	fair	.....	.....	1.10	62	48
	Gravenstein	7	XX	Medium	green	slack	1.00	61	39
L. Woolverton	Gravenstein	46	XX	fair	green	slack	.96	60½	35½
W. J. Drope	B. Pippin	6	XXX	good	firm	tight	.90	60	30
A. H. Pettit	B. Pippin	12	XXX	fair	.....	tight	.90	60	30
	B. Pippin	4	XX	fair	.....	.....	.90	60	30
	Colvert	20	XXX	fair	.....	slack	.85	59½	25½

Tomatoes : Package,—4¾ in. x 12 in. x 18½ in.; cost, 8c.

ST. CATHARINES.

Shipper.	Quantity.	Grade.	Maturity.	Condition at market.	Price.	Charges.	Net proceeds.
J. H. Brodrick	17	XXX	rather green	sound, firm	.61	29	32
W. H. Bunting	15	XX	do	sound, firm	.85	35	50

GRIMSBY.

W. J. Andrews	30	XXX	rather green	sound, firm	.57	29	28
---------------	----	-----	--------------	-------------	-----	----	----

The difference in the tomato prices was due again, not to a difference in value, but to the fickleness of the auction method.

Comparing Winnipeg prices with those obtained in local and other markets this year, Mr. W. H. Secord, of Homer, Ont., writes: "I received as high as \$1.25 per 11-quart basket for Reine Claude plums in Montreal, and it took eight baskets to fill five boxes. As to peaches, I shipped the same peaches to Toronto the next day after I delivered to you and received 80 cents per basket, which would net 63½ cents deducting freight, commission, and basket. On the whole, in my opinion, the prices realized do not equal those which we are receiving in the East this year. I am not prepared to say how it would be in a year like last, of plenty."

Mr. J. W. Brennan, of Grimsby, writes: "Our returns on peaches shipped the following day to Ottawa and Quebec netted us clear \$1.25 and \$1.29 per case.

"Just received returns from Glasgow, where a car of pears arrived in bad order, much too ripe. In that consignment our little lot brought us 70 cents clear; on others we believe less than one-half were realized."

(2) METHOD OF SALE. The fruit was sold by auction, and the method exhibited its usual advantages and disadvantages. It is inclined to unsteadiness. A glance over the tables of returns given above will reveal differences in prices that are not due to differences in values. On the other hand, this method enables rapid disposal of the goods, which is of importance for perishable fruits, and quick returns, which is satisfactory to

the shipper. With such limited experience, however, the writer does not feel competent to advise upon the method of selling, whether this or any other.

(3) CHARACTER OF FRUIT DEMANDED. If one may judge from the sale of two cars of mixed fruit, the market there demands well-matured, bright fruit of clean, sound appearance. Well-colored Crawford peaches sold much in advance of Elbertas, which, though large, were mostly hard and green. Immature fruit is not wanted. Many of the pears in the second day's sale were green and very firm, and sold low accordingly. Of apples, well-colored Gravensteins, Wealthy, Alexander, and St. Lawrence, commanded the best prices.

(4) BEST DEGREE OF MATURITY. A careful examination of the fruit at Winnipeg revealed the fact that the most mature fruit at shipping point was in best condition at the market. Evidently all classes of fruit may be left on the tree until full size and characteristic color have been attained, but should be picked firm, and before the yellow tints, significant of ripeness, have begun to appear. Peaches and pears that were shipped hard and green reached the market without any perceptible change; those that were semi-firm at shipment had become sufficiently mellow to be in good usable condition. A special report was obtained of one box of peaches, among the primest of our two lots. This box at shipping point was reported "semi-firm, a little too ripe for shipment," and the peaches were large and well-colored. It was packed on September 15th, loaded September 16th, and sold at Winnipeg September 23rd. On Monday, September 26th, a report was obtained to the effect that only a few of the peaches were then mellow enough to use, and that by the end of the week the whole of the box would probably be sufficiently ripe.

It seems an opportune moment to emphasize the importance of choosing carefully the time for picking and, for fancy fruits at least, of going over the tree several times and picking only the ripest at each picking. This phase of the question stands out clearly as a result of our experiment. The fruit should be allowed to attain on the tree its distinctive character, in size, color, and flavor. If, in these three particulars, the fruit is immature when picked, it will remain immature. And further, if fruit sufficiently mature to have its distinctive size, color, and flavor when picked, cannot be safely carried to market, then it is detrimental to the reputation of the fruit to carry any. The shipping of immature fruit, it is admitted, has done as much as anything to depreciate prices in distant markets.

What does the grower gain by the careful selection of fruit on the tree and by successive pickings? He gains (1) a greater quantity of fruit, since the smaller specimens are allowed to grow; (2) fruit of better appearance, on account of greater size, more uniform size, and higher color; (3) fruit of better quality; (4) in a discriminating market, better prices; (5) a better reputation.

(5) PACKING AS IT APPEARED AT THE MARKET. By packing is meant not merely the placing of the fruit in the package, but also the use of wrappers and fillers.

Two effects should be borne in mind in the packing of fruit: First, the condition of the fruit; second, the appearance of the package.

Packing should first of all be tight; and herein much of the work done for the two trial shipments was defective. Many of the boxes, upon being lifted to load in the car, rattled, which indicated a looseness of the fruit in the package. It is scarcely necessary to remark that such looseness is an unfavorable factor in the carrying of the fruit, and that it is useless to secure the package in its place in the car when the fruit within the package is capable of being displaced. Further, the looseness of the fruit, when the package is opened for exhibition and sale, impresses the dealer unfavorably, and tends to depreciate the price. Tightness of packing is just as necessary when the fruit is wrapped, as when it is not; for with loose packing and heavy wrappers, such as occurred too frequently in this shipment, the purchaser receives much less fruit than, if he judges by the size of the package, he expects and is entitled to receive. To illustrate: the weight of a box of pears put up by one shipper was 31 pounds; the

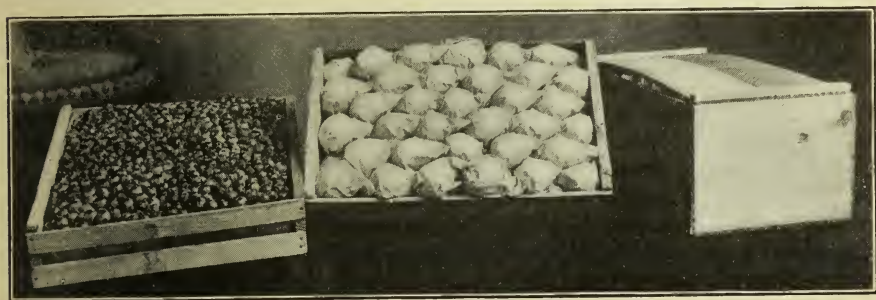


Fig. 10.—(1) The California grape-crate, a shallow square container holding 4 square trays.

(2) A box of pears packed by J. F. Brennan, of Grimsby. The pears are heaped toward the middle by selecting slightly larger pears for the middle; this heaping gives the effect, when the lid is on, as seen in (3) of this figure.

(3) Is a box of California pears 9 in. x 12 in. x 18½ in. By this style of packing the pears are squeezed when the lid is on, an effect similar to squeezing apples when heading the barrel.

weight of a box of same size, containing the same variety and grade of pears, put up by another shipper in the same car, was 23 pounds. The pears in both boxes were wrapped, but in the one the pears were squeezed, and in the other they were slack.

Some of the apples in our shipment were packed in layers, with a stiff heavy paper, cut the size of the box, between layers. This paper, while good in itself, was made by some of the packers the occasion for very loose packing. In fact, in some of the boxes there was no attempt at close packing; the apples being put in loosely on top of the paper, and faced stem upwards so as to present a level surface for the next paper. Such methods result to the packer in a considerable saving of apples, but rob the consumer, besides allowing bruising in transit.

FILLERS. There is a practice in packing that cannot be too strongly condemned, namely, filling in the slack with odd pieces of paper, excelsior, and small and inferior specimens of fruit. The effect of this upon

the intending purchaser, when the box is opened, has to be seen but once to impress anyone with the unwisdom, the shortsightedness of this style of work. The ragged, untidy, make-shift appearance, the evident lack of skill, the danger that dishonest intention be imputed, are some of the unfortunate consequences. The filling known as "Excelsior" is in this regard made to cover a multitude of sins, and for this reason, if for no other, its use should be discouraged. Especially is excelsior superfluous when the fruit is wrapped, as then it is not required to serve its only useful purpose, namely, to prevent the fruit from bruising. Yet by several of our packers excelsior was used to fill up the slack between the top layer of peaches and pears and the lid; whereas, with a proper selection of size of specimens and ordinary care and skill in packing, there should have been no slack. With excelsior at the bottom of the box, and excelsior at the top, and excelsior sticking out at the crevices and forming a ragged edge all around, the appearance of some of our peach boxes compared very unfavorably with the neat and tidy Californian boxes in the same warehouse, and, it is only just to say, with other boxes sent out by our own packers.

WRAPPING PAPER. The writer is inclined to advise, but without having personally made an exact and thorough test, that tissue paper is not heavy or strong enough to protect Ontario peaches in shipment. Tissue paper may do well enough for pears, or for California peaches, which are drier and firmer than our own; but for the soft and juicy peach of Ontario a manila paper seems to give better results. This, however, should not be so thick and heavy as to bulk up unnecessarily, and particularly, should be of a size proportioned to the size of the fruit to be wrapped. Here again, the long-suffering consumer, who thought he was paying for prime Ontario peaches, found upon opening some of the boxes that he had purchased large twists of paper, with a comparatively insignificant peach done up in a pocket at the end of each. In many cases, the paper used was altogether too large. Now, what does this fact signify? Evidently, that the packers were not in the habit of wrapping their peaches for market, were not provided with paper of the proper size and weight, and when the time came for them to fulfill this contract, were forced to use whatever was at hand, or could be procured at short notice. One packer, driven to desperate expedients, but as he confessed, well aware of the ludicrous nature of the performance, used toilet paper for wrapping his pears. It is quite evident that the business of packing the fruit has not yet received serious attention from many of our fruit-growers. The time is coming, and cannot come too soon, when peaches will be wrapped and boxed for shipment to our local markets.

V. SOME NOTES ON DIMENSIONS OF PACKAGES IN RELATION TO COOLING.

The question of size and shape of package to be used with any particular variety is of first-class importance in storing or shipping fruit; important not merely in respect of cost and convenience of package, or the degree of firmness of the fruit that will sustain the weight of the fruit above it in the package; but important more especially on account of the rate at which the whole of the fruit in the package will cool to the temperature of the refrigerator. Slowly ripening fruits, such as winter apples and winter pears, may be safely packed in a case that cools slowly. But quickly ripening fruits, to be preserved, must be cooled very quickly to a temperature of 40 degrees or below, in order to delay the ripening and decaying processes. With a peach that will ripen and begin to decay two days after picking, a few hours' delay in cooling will make relatively a great difference in the length of its life. For such fruit as this, a package must be used that allows the most rapid rate of cooling.

With these principles in mind, the following temperature tests were made at the Cold Storage Warehouse at the Agricultural College. Four packages were filled with apples, and long thermometers were inserted in the midst of the fruit, the bulbs being at the centres of the packages and the stems and reading scales standing out of the packages in view of the observer. The packages were then headed, placed in a warm room and kept for a week until they reached a uniform temperature of 64 degrees F., and then were transferred to a room in the warehouse that is kept at a temperature of from 32 degrees to 34 degrees. The packages were:

1. An ordinary large apple barrel.
2. A bushel box 10x11x20 inches, with close joints practically air tight.
3. A Georgia peach carrier 10x11x20 inches, with open spaces at sides; the fruit within was packed in the six baskets, and among these baskets were empty spaces permitting circulation of air.
4. A half-bushel box 5x11x20 inches, with open spaces at sides, bottom and top.

(1)		Time of observation		Amount of cooling			
Package		a.m.	p.m.				
Barrel	10.30 to 2.00	3 $\frac{1}{2}$ hours	64.5	60.5	equal	4 °	
Bushel (closed joints).....	10.30 to 2.00	3 $\frac{1}{2}$ hours	64.5	57.5	"	7 °	
Bushel (open).....	10.30 to 2.00	3 $\frac{1}{2}$ hours	64.5	54	"	10 $\frac{1}{2}$ °	
Half-bushel	10.30 to 2.00	3 $\frac{1}{2}$ hours	64	51	"	12 °	
(2)		p.m.	p.m.				
Barrel	2.00 to 8.00	6 hours	90.5	57	"	3 $\frac{1}{2}$ °	
Bushel (closed joints).....	2.00 to 8.00	6 hours	57.5	50	"	7 $\frac{1}{2}$ °	
Bushel (open joints)	2.00 to 8.00	6 hours	54	43	"	11 °	
Half-bushel	2.00 to 8.00	6 hours	51	40	"	11 °	
Total :		a.m.	p.m.				
Barrel	10.30 to 8.00	9 $\frac{1}{2}$ hours	94.5	57	"	7 $\frac{1}{2}$ °	
Bushel (closed joints).....	10.30 to 8.00	9 $\frac{1}{2}$ hours	64.5	50	"	14 $\frac{1}{2}$ °	
Bushel (open joints).....	10.30 to 8.00	9 $\frac{1}{2}$ hours	64.5	43	"	21 $\frac{1}{2}$ °	
Half-bushel	10.30 to 8.00	9 $\frac{1}{2}$ hours	64	40	"	24 °	

The half-bushel, it may be seen, had cooled to a sufficiently low temperature, 40 degrees, in $9\frac{1}{2}$ hours; the Georgia crate, with open sides and open packing, cooled in the same time within 30 degrees of that temperature. By the next morning at eight o'clock the half-bushel had cooled to 35 degrees, the Georgia crate to 35 degrees, the bushel to 39 degrees, and the barrel to 47 degrees. Two days after the commencement of the observations the barrel was still at a temperature of 38 degrees, 6 degrees above that of the room.

The application of these facts is obvious: Winter apples and winter pears may, so far as temperature and ripening are concerned, be packed in barrels. For winter pears, no package smaller than the bushel box need be used. Between the half-bushel and the bushel, there was in the above test a difference of 12 hours in cooling from a temperature of 64 degrees to 40 degrees; but this difference is insignificant with slowly ripening fruit.

For summer and early fall apples the barrel is too large a package, and much of this fruit shipped in barrels turns out badly by reason of the slowness of cooling. Where decay occurs it is usually at the centre of the package, because this is the last to cool. The bushel box, cooling to the centre in half the time that the barrel requires, is for this reason preferable to the barrel for early apples.

For early and quickly ripening pears, the bushel box is too large a package for best results in long shipments, unless it be in the form of the Georgia carrier with open sides, when it resolves itself virtually into a number of small packages with spaces between. The writer chanced to call upon a retail dealer at Winnipeg and found him unpacking some Ontario pears, Bartlett's, from bushel boxes. There was a marked difference between the pears next to the package and those at the centre. Those at the outside were still green and firm, while those at the centre were quite ripe, and many of them soft and pulpy. The use of the half-bushel box in this instance instead of the bushel, would have hastened the cooling of the centre of the package by 12 hours, and would likely have preserved the fruit at the centre.

All results of storage and shipping experiments concur in pointing out the necessity for quick cooling of tender fruits. Such fruits should be packed in shallow cases and placed in a cold store as soon as possible after picking.

Ontario Agricultural College and Experimental Farm

THE RESULTS OF FIELD EXPERIMENTS WITH FARM CROPS—1904.

BY C. A. ZAVITZ, PROFESSOR OF FIELD HUSBANDRY.

The work in the Experimental Department consists in planning the various experiments; laying out, seeding, and looking after the field plots; harvesting, threshing, weighing, and testing the grain; taking up, weighing, counting, testing and storing the potatoes and roots; cutting, weighing, and harvesting the grass, corn, and fodder crops, etc., and also in picking by hand the samples of grain grown on the plots, some to be sown on the plots the following year, and some to be distributed for co-operative experimental work throughout Ontario. But few people realize what a large amount of very careful thought is required in planning, supervising, and examining these plots, and in studying, comparing, and summarizing the results for presentation in reports, bulletins, newspaper articles, and lectures.

EXPERIMENTAL GROUNDS. About fifty acres of land, divided into about 2,000 plots, are used for agricultural field experiments, conducted with varieties of grain, root, tuber, grass, clover, fodder, silage, and miscellaneous crops; with artificial, green, and farmyard manures; with methods of cultivation, selection of seed, dates of seeding, etc.—all with the greatest care, and for several years in succession—in order to secure strictly accurate and reliable results. These experiments deal with the crops grown on over nine-tenths of the cultivated land in Ontario, that is, fully 10,000,000 acres.

EXPERIMENTAL PLOTS. The experimental grounds have a gentle slope towards the southwest, and the soil is what might be termed an average clay loam. Nearly one-quarter of the land is manured each year with twenty tons (about twelve loads) of farmyard manure per acre. It will thus be seen that the most of the land receives farmyard manure once every four years. No commercial fertilizers are used except in distinct fertilizer experiments, which occupy from two to three acres each year, and on which tests are made to ascertain the comparative value of different fertilizers with different crops. The plots vary in size according to the requirements of the different experiments, and the yields per acre are determined from the actual yields of the plots in every instance.

RESULTS OF EXPERIMENTS.

All our field experiments are conducted for at least five years before any of them are dropped. For the results of many of the tests

which were carried on for five years previous to 1904, the reader is referred to former reports. The results of some of the experiments which have yet been conducted for only one or two years are held back until the tests can be carried through at least another summer. As different seasons vary so much in temperature, amount of rainfall, etc., the average results of experiments continued for several years are of much greater value than those secured from only one year's work. We submit the results with much confidence in their reliability and in their real, practical value. The writer has had good reason to believe that the work of the Experimental Department is being appreciated by the farmers of the Province, and that the results are being studied more and more each succeeding year. I shall limit my remarks on each separate experiment, the results of which are here presented, to a few of the points which seem to be of the greatest value to the agriculture of Ontario.

CONDITIONS OF THE WEATHER DURING THE PAST SUMMER.

In studying the results in the bulletin here presented, we should keep in view the conditions of the weather during the growing season. The past summer has been comparatively cool and wet. According to the report of the Bureau of Industries, the mean temperature for April was only 37.6 degrees as compared with 43.3 degrees in 1903, and 41.9 degrees above zero for the period extending from 1882 to 1903. The average temperature for each of the months of May, June, July, August, and September, for 1904, was lower than that for each of the corresponding months in the average of the past twenty-three years.

The total precipitation for the six months, starting with April, was 19.96 inches, according to the report of the Bureau of Industries for Ontario, and 19.87 inches according to the report of the Physical Department of the College at Guelph. This amount of rainfall is greater than for several years at the College, even including 1902, in which year the precipitation was also very large. According to the report of the Bureau of Industries, the average rainfall for Ontario from the year 1882 to 1903 was 15.7 inches for the six months commencing with April in each year. It will therefore be seen that the rainfall for 1904 was about 27 per cent. greater than for the average of the past twenty-three years. The rainfall at the College in July was exceedingly heavy, there being practically five inches during the month.

The first seeding which took place in the experimental plots in 1904 was on the 22nd of April. This was twenty days later than the first seeding in 1903. The grains were mostly sown during the last week in April and the early part of May. The mangels, sugar beets, carrots, and potatoes were mostly planted in May, and the corn, sorghum, turnips, rape, millet, beans, and part of the potatoes in June.

FLUCTUATIONS IN THE AREAS OF FARM CROPS IN ONTARIO.

It is indeed interesting to study the crop production of Ontario from year to year. Owing to changed conditions brought about by means of fluctuations in the market prices of farm products, the introduction of new and improved varieties of farm crops, the amount of farm help available, the damages caused by insect pests and fungous diseases, as well as by other causes, we find considerable variations in the relative areas devoted to our principal farm crops over a series of years. A table has been compiled from the reports of the Ontario Bureau of Industries, and it is presented here to show the area devoted to each farm crop in Ontario in 1904, the average yield per acre of each crop for the past twenty-three years, and the percentage of increase or decrease in the area used for each of the crops for the past five years. The crops mentioned in the table are arranged in the order of their increase or their decrease per acre for the five years from 1899 to 1904.

Farm Crops.	Acres of each Crop in Ontario in 1904.	Yield per Acre. Average 23 Years.	Percentage Increase or Decrease in Area in last 5 Years.
Barley	772,434	1,301 lbs.	57 Increase
Mangels	71,344	459 bus.	34 "
Beans	50,892	1,026 lbs.	26 "
Pasture	3,183,673		18 "
Hay and clover	2,926,207	1.45 tons	17 "
Oats	2,654,936	1,217 lbs.	12 "
Corn for silage or fodder.....	193,115		12 "
Corn for husking ..	329,882		1 Decrease
Rye	130,702	913 lbs.	5 "
Turnips	133,207	487 bus.	13 "
Potatoes	133,819	115 bus.	20 "
Buckwheat	100,608	936 lbs.	23 "
Winter wheat	608,458	1,218 lbs.	42 "
Spring wheat	225,027	942 lbs.	44 "
Carrots	6,634	348 bus.	44 "
Peas	339,260	1,170 lbs.	54 "

From the figures here presented, it will be seen that the areas devoted to the growth of barley, mangels, and beans are being increased rapidly at the present time. It will be noticed also that the hay and pasture land has been increased 17 and 18 per cent. within the past five years. These two crops alone now cover about six million acres of Ontario land each year. The increase in the amount of pasture and hay land in recent years has probably been due, to a very great extent, to the greater number of cattle which is being kept at present as compared with former years. A very noticeable feature in connection with this study is the fact that the area devoted to each of the crops—winter wheat, spring wheat, carrots, and peas—has decreased upwards of 40 per cent. in the last five years. We find that in 1897, 896,735 acres were used for the pea crop. From that time to the present, the acre-

age has gradually decreased until in 1904 there were only 339,260 acres of peas. This great decrease in Ontario's pea crop has been brought about largely through the ravages of the pea weevil. As the acreage has been reduced to such a large extent, the few who grow peas at the present time in the older parts of the Province should be very sure to fumigate the crop with carbon bisulphide immediately after harvest, in order to check the ravages of this troublesome pest. For the method of treatment, the reader is referred to another part of this report. We submit the foregoing table, believing that it contains much useful information in studying the present conditions regarding the growing of farm crops in Ontario.

YIELDS PER ACRE OF DIFFERENT CLASSES OF GRAIN.

Besides making a careful study of the varieties of grain crops of any one class, it is well for us to compare the different classes of grain one with another. In the table presented under the previous heading, it will be noticed that the average number of pounds of grain per acre per annum for Ontario for the past twenty-three years has been as follows: Barley, 1301 lbs.; winter wheat, 1218 lbs.; oats, 1217 lbs.; peas, 1170 lbs.; beans, 1026 lbs.; spring wheat, 942 lbs.; buckwheat, 936 lbs.; and rye 913 lbs. Thus we see that of the principal farm crops which have been grown throughout Ontario for the last twenty-three years, barley has given the largest number of pounds of grain per acre. The increase in the yield of barley over oats is fully 14 per cent.

In comparison with the results for twenty-three years, it might be interesting to notice the results of some of the same crops over Ontario for the years 1902, 1903, and 1904. Taking the average of these three we find that the annual production in yields of grain per acre are as follows: Barley, 1584 lbs.; oats, 1390 lbs.; winter wheat, 1360 lbs.; peas, 1128 lbs.; spring wheat, 1082 lbs.; beans, 970 lbs.; and rye, 941 lbs. These results again show that the barley comes first, and the oats second in yield of pounds of grain per acre. It also shows that the yields of all the crops except beans have been considerably higher during the last three years than they were in the average of the past twenty-three years.

As some of these same kinds of crops were distributed throughout Ontario in the spring of 1902, 1903, and again in the spring of 1904, for co-operative experiments, a reference to the results obtained will be interesting for comparison with the results in general farm practice. It should be understood that the crops grown throughout Ontario are the averages of a large number of tests made on separate farms. The average soil on which any one crop would be grown would, therefore, not be exactly the same as the average soil used for the experiments with other crops. It should also be remembered that the results here presented are those of small plots, and not of large fields.

The results, however, were obtained from very carefully conducted experimental work.

Class of Crops.	Variety.	Average Yield per Acre.				
		Tons of Straw 3 Years.	Pounds of Grain.			
			1902.	1903.	1904.	Average 3 Years.
Emmer	Common	1.7	2,126	1,810	1,658	1,865
Barley	Mandscheuri . .	1.5	1,672	2,158	1,739	1,856
Oats	Early Britain . .	1.6	1,737	1,853	1,685	1,758
Peas	Siberian	1.5	1,166	1,955	1,692	1,604
Hulless Barley . .	Black	1.4	1,536	1,448	1,607	1,530
Spring wheat . .	Wild Goose . . .	1.4	1,302	1,078	1,169	1,183

We notice from the results of the co-operative work over Ontario that the barley has given a greater yield than the oats. We also notice that the Emmer occupies the highest place in yield of grain per acre, being slightly ahead of barley in grain production. This grain has not been grown in general cultivation throughout Ontario, but will be described more fully further on in this report. It will be observed that the yields in connection with the co-operative work throughout Ontario for the last three years have been somewhat greater than the yields given in the report of the Bureau of Industries.

An experiment was conducted at the College in 1902, in 1903, and again in 1904, in order to obtain some definite information regarding the comparative yields of the different classes of farm crops, grown and handled under as nearly uniform conditions as possible. The seeding took place on April 24th in 1902, on May 5th in 1903, and on May 4th in 1904, and the experiment was conducted in duplicate in each year. The figures here presented give the average results, therefore, of six separate experiments in growing farm crops under similar conditions within the past three years.

Class of Crops.	Variety.	Average results for three years—Six tests.				
		Date of ripening.	Height.	Rust.	Yield per acre.	
					Straw.	Grain.
		August	Inches.	Per cent.	Tons.	Pounds.
Barley	Mandscheuri . .	5	40	9	2.0	2,714
Emmer	Common	21	39	5	2.1	2,634
Oats	Joanette	16	40	7	3.0	2,634
Hulless Barley . .	Black	6	31	13	2.1	2,473
Early Oats . . .	Alaska	9	42	11	2.2	2,399
Hulless Barley . .	White	9	34	5	1.8	1,942
Spring Wheat . .	Wild Goose . . .	29	48	13	2.2	1,716
Spring Rye . . .	Common	16	51	4	2.1	1,536
Vetches	Spring	Sept. 12	38	..	2.0	7.19

We notice from the table here presented that the barley again comes ahead of the oats in number of pounds of grain per acre. The barley is followed by the Emmer and the Joannette oats, which have given exactly the same yield of grain per acre. It might be well to here mention that, on the average, barley has about 12 to 15 per cent., Emmer about 22 per cent., and oats about 30 per cent. of hull. The Joannette variety of oats, however, has a particularly thin hull, the average percentage of hull being only about 23 per cent. Of the crops under experiment, the Mandscheuri barley, Black Hulless barley, Alaska oats, and White Hulless barley were the earliest; and the Common Spring vetches, and the Wild Goose spring wheat were the latest in reaching maturity. There is not much difference in the strength of straw of the Mandscheuri barley and the Common Emmer. Both, however, are considerably stronger than that of the Black Hulless barley. It should be remembered that the results presented in the last two tables are obtained from plots, and that the results taken from the reports of the Bureau of Industries were obtained from large areas of land.

BARLEY.

Barley is one of the hardiest of the cereals and can be raised through a great range of climate. It is cultivated with success north of the Arctic circle, and at high altitudes in the torrid zone. This crop has been under cultivation in the southern part of Europe from the earliest times.

Barley was formerly grown extensively in Ontario for shipment to the United States for malting purposes. The high tariff placed on barley by the United States Government, however, was instrumental in shutting out a large quantity of the Ontario barley from the markets of that country. The acreage, therefore, decreased from year to year, until the introduction of large yielding varieties for feeding purposes and the demands of the live stock industry called for a greater amount of valuable feed. By examining the reports of the Bureau of Industries, we find that the acreage of barley in Ontario has increased no less than seventy-six per cent. within the past seven years. In 1904, there were upwards of three-quarters of a million acres of Ontario lands devoted to the growing of this important crop.

VARIETIES OF SIX-ROWED BARLEY. Ontario seems particularly adapted to the growing of six-rowed barley; hence a good deal of attention has been given by the Experimental Department to secure those varieties which would likely give better results throughout the Province than the kinds which had been grown in former years. In the five years from 1889 to 1893, eighty-six different varieties of barley were grown in the experimental grounds. After five years' tests were completed, the poorest varieties were dropped from the experiment, and those which proved the most successful were retained for future experiments. New varieties were added from time to time, all of which

were tested for at least five years. A few varieties have now been grown for fifteen years in succession, without change of seed. The results of these varieties are exceedingly interesting and worthy of careful study. The following are the average yields of grain per acre of each variety for the whole period of fifteen years, and also for the last five years :

Varieties.	Average yield of grain per acre.	
	1890-1904, 15 years.	1900-4, 5 years.
Mandscheuri	71.4	73.5
Common six-rowed	62.4	68.7
Oderbrucker	64.4	68.0
Mensury	60.0	63.1

The results show that the Mandscheuri gave decidedly the greatest yield per acre of the four varieties for the whole period of fifteen years, and also for the last five years. The Mandscheuri gave an average of 9.3 bushels per acre per annum over the Common Six-rowed barley in the average results for fifteen years. The average area devoted to barley in Ontario from 1882 to 1904 is given as 633,290 acres per annum. An increase of nine bushels of barley per acre throughout the Province would, therefore, amount to an increase of over five million bushels of barley in Ontario annually. This increase at fifty cents per bushel would amount to about two and a half million dollars. Two and a half million dollars annually would pay the running expenses of about thirty Agricultural Colleges like the one located at Guelph. The Mandscheuri barley was imported from Russia by the Ontario Agricultural College in the spring of 1889. Not only has it made a very excellent record at the College, but it has given high results in the co-operative experiments throughout Ontario and has been grown in general cultivation very successfully during the past few years. In looking up the records of the Bureau of Industries, we find that the average yield of barley throughout the Province for the period of ten years from 1895 to 1904, inclusive, is 29.3 bushels per acre; while that for the period of ten years from 1885 to 1894 inclusive was 24.85 bushels per acre. This shows an annual average increase of about 4 1/2 bushels per acre for the latter as compared with the former period of ten years. From these results, does it not appear as though the introduction of the Mandscheuri barley by the Ontario Agricultural College has been worth to the Province of Ontario within the past ten years an annual money value equal to more than fifteen times the entire cost of the College?

Among the other varieties of six-rowed barley which have been grown in the Experimental Department besides those already referred to, mention might be made of the California Brewing, Scotch Im-

proved, Imperial Six-rowed, Success, and Ohio Beardless. Of these varieties, however, the only one which has given a very high average yield per acre is the California Brewing. This, however, is a coarse barley with a very stiff beard and straw of rather poor quality.

VARIETY OF TWO-ROWED BARLEY. The two-rowed barley is easily distinguished from the other species by the head being somewhat elongated, and by there being only two rows of grain from one end of the head to the other. The heads of some varieties are long and slender; while those of other varieties are short, very broad at the base, and taper towards the extremity. The two-rowed barley is largely cultivated in England and Central Europe, but is not grown to any extent in Ontario, although great efforts were made a few years ago by the Dominion Government to have it grown extensively by Canadian farmers for exporting to England. With this object in view, the Canadian Government imported 10,000 bushels of the Carter's Prize Prolific barley from England, and sold the same to Canadian farmers at \$2 per bushel, in order to get it introduced. This variety, however, has not given very satisfactory results throughout the Province.

According to the results of eleven years' experiments with about sixty varieties of two-rowed barley, we find that the highest yielding kinds are not as productive as the most prolific varieties of the six-rowed class. In the average of eleven years' tests with six varieties of two-rowed barley, the greatest yields were produced by the Two-rowed Canadian, New Zealand Chevalier, Jarman's Selected Beardless, and French Chevalier.

In 1904, seventeen varieties of two-rowed barley were grown in the experimental grounds. The highest yields were produced by the Two-rowed Canadian and Selected Canadian Thorp varieties; and the lowest yields were produced by the Invincible, Standwell, and Frederickson varieties. The last three varieties were recently imported from Europe. The Standwell and the Invincible were imported from England, and the Frederickson from Germany. The Chevalier two-rowed barley has been used considerably for mixing with Siberian or Banner oats for seed purposes. As the Chevalier barley is late in maturing, it ripens about the same time as either of these varieties of oats, and a mixture composed of the Chevalier barley with one of these varieties of oats usually produces a heavy yield per acre.

VARIETIES OF HULLESS BARLEY. The grain of the Hulless barley usually weighs about sixty pounds per measured bushel, while the standard weight of the common varieties is forty-eight pounds per bushel. The skin of the Hulless varieties is thin and transparent, and is white, purple, or black in color. In some respects the grain resembles wheat more than barley. The straw is apt to be weak, and, when ripe, often becomes so brittle that the heads are easily broken off. Some of the varieties possess heads with six rows, and others with two rows.

We have had ten varieties of Hulless barley under experiment for five years in succession, and find that the Guy Mayle heads the list with an average of 54.4 bushels per acre, taking sixty pounds as the standard weight per measured bushel. This is followed by the Black Hulless with 51.5; the Hungarian, 50.2; the Purple, 49.2; the Winnipeg No. 2, 46.9; the Hog, 45.9; the Large Skinned, 42.8; the New White Hulless, 42.1; and the Ideal, 40.2 bushels per acre. In 1904, the highest yields were produced by the Guy Mayle, 59.7 bus.; Black Hulless, 54.9 bus.; Purple, 53.2 bus.; and Hungarian 53.1 bushels per acre.

The Guy Mayle variety, which stands at the head of the list in yield per acre for five years, and also for 1904, produces a grain of purple color, and possesses straw which is comparatively strong for a Hulless barley. This barley was distributed throughout Ontario in 1904 for co-operative experiments. In the average of thirty-three reports of successfully conducted experiments with the Guy Mayle and the Black Hulless varieties, it was found that not only did the Guy Mayle give the larger yield of grain per acre, but it was the most popular of the two varieties among the experimenters. This is considered to be the most promising variety of Hulless barley which has been grown at the College.

PREVIOUS CROPPING OF LAND FOR BARLEY. In the spring of 1901, a strip of land two rods in width and forty rods in length was divided into thirty-two plots. Paths five links (39.6 inches) in width were allowed between the plots. The land is very level throughout, and had been uniformly cropped previous to the date here mentioned. In the spring of 1901, the whole range was sown to early oats. No. 1 plot was seeded with Common Red Clover, No. 2 plot with Alsike Clover, No. 3 plot with Timothy, and No. 4 plot received no clover or grass seed. Similar seedings to these were repeated until the whole range was seeded according to the plan outlined above. It will, therefore, be seen that there were eight plots of Common Red Clover, eight plots of Alsike Clover, eight plots of Timothy, and eight plots left without seeding. After the oats were cut, the plots were carefully edged. Both the clover and the timothy made good growth in the autumn. In the following spring, the growth of the three crops on the twenty-four plots was excellent. The range was divided into two sections, and each section into four divisions, each division containing one plot of Common Red Clover, one plot of Alsike Clover, one plot of Timothy, and one plot without any crop. The land in No. 1 division was plowed after the first crop of the season had received its full growth and before it had been removed from the land; No. 2 division was plowed immediately after the first crop of the season had been removed; No. 3 division was plowed before the second crop had been removed; and No. 4 division was plowed immediately after the second crop had been removed from the land. The remaining sixteen plots were an exact duplicate of the first section. The land was cultivated on the surface in the autumn and was sown with mangels in the spring of 1903. The Sut-

ton's Mammoth Long Red variety was used in the first section, and the Yellow Leviathan variety in the second section. On the same land, we sowed barley in the spring of 1904, using the Mandscheuri variety on the first section, and the Oderbrucker on the second section.

Taking the average of all the experiments in 1903, we find that the Common Red Clover land produced 2.1 tons and the Alsike Clover land 3.6 tons of mangels per acre more than the Timothy land. In the average results of the experiments for 1904, we find that the Common Red Clover land produced 8 bushels, and the Alsike Clover land 7.2 bushels of barley per acre more than the Timothy land. The greatest average yield of roots per acre (35.5 tons) in 1903, and the greatest average yield of barley per acre (58.2 bushels) in 1904 were produced on land which had received the first crop of Alsike Clover as green manure. It is intended to sow these plots with another crop in 1905, in order to study the manurial effects of the different crops plowed under for a series of years. This whole experiment is being repeated at the present time, as thirty-two other plots were treated in 1904 in the same manner as the plots previously referred to were treated in 1901.

We have previously conducted a series of experiments at the College in order to ascertain the comparative value of clover and grass sod for crop production. We first grew clover and grasses upon separate plots and removed the crops, after which the land was plowed and other crops were sown. The results, therefore, show the influence of the roots remaining in the land upon the productiveness of the crops following the clovers and grasses. In 1902, barley was sown after each of four varieties of clover and three varieties of grasses in four different places in our experimental grounds. The average results of the four tests in pounds of barley per acre were as follows: Red Clover, 1516; Lucerne, 1450; Alsike Clover, 1427; Mammoth Red Clover, 1408; Meadow Fescue Grass, 1068; Orchard Grass, 1015; and Timothy, 946. It will, therefore, be seen that the Red Clover sod gave an increase over the Timothy sod of 570 pounds, or nearly 12 bushels of barley per acre.

The results of this experiment help us to appreciate the beneficial influence on the soil from the growing of clover.

WINTER BARLEY. Within the last twelve or fourteen years, we have sown winter barley each autumn. When the winters have been unfavorable, however, the barley has usually been winter-killed, and in those seasons in which the barley survived the winter, the results have been exceedingly good. In eight out of the past twelve years, the barley has survived the winter well, the average yield for the eight years being 64.1 bushels per acre. The crop during the last winter was considerably winter killed, but the plants which were alive in the spring made an excellent growth, and the yield obtained this season amounted to 31.8 bushels per acre. This, however, is only about one-half as large a yield as that shown for the average results for eight years. By making use of the same variety of winter barley from year to year, we hope

that it will improve in hardiness as time advances, and that possibly we may secure a variety which will withstand our winter seasons without much risk of loss through winter killing.

OATS.

Oats have been cultivated for such a long time without any definite record in regard to their origin that their native country is still unknown. The wide range of soils on which oats can be grown successfully, and the comparatively low temperature in which they come to their maturity, have rendered them well adapted for cultivation in many countries. In some countries of the world, the cultivation of oats extends very far north, even to the 65th degree of latitude. In Ontario, the area devoted to oats each year is greater than that used for the cultivation of any other kind of grain. The number of acres used for oats in Ontario was 2,654,936 in 1904, and 2,058,487 acres in the average of the past twenty-three years. The average yield of oats per acre throughout the Province has been gradually increasing in recent years, probably due to the general introduction and cultivation of larger yielding varieties, such as the Siberian, American Banner, Ligowa, and Newmarket; and the adoption of better methods of farming. According to the reports of the Ontario Department of Agriculture, the average yield of oats per acre for the last ten years (1895-1904) is fully eleven per cent., or 3.8 bushels, higher than for the ten years previous (1885-1894).

VARIETIES OF OATS. No less than two hundred and seventy-five different varieties of oats have been grown in our experimental grounds within the past sixteen years. The object in testing such a large number is to ascertain the few very best varieties which are most suitable for the different soils and localities throughout the Province. Eight of these varieties have now been grown under exactly similar conditions, without change of seed, for fifteen years in succession. The average results for the fifteen years in weight per measured bushel, yield of straw per acre, and yield of grain per acre are as follows:

Varieties.	Weight per measured bushel.	Yield of straw per acre.	Yield of grain per acre.
	Pounds.	Tons.	Bushels.
Joanette	35.5	3.0	90.5
Siberian	35.2	2.6	87.8
Waterloo	32.6	2.6	87.3
Oderbrucker	32.7	2.5	86.7
Probsteier	33.4	2.5	86.2
Bavarian	32.6	2.8	84.8
Egyptian	36.3	2.9	76.9
Black Tartarian	30.8	2.7	71.1

During the last five years in which these eight varieties have been grown side by side, we find the yield of grain per acre to be in the

following order, starting with the highest yielding variety: Siberian, Waterloo, Probsteler, Oderbrucker, Bavarian, Joannette, Egyptian, and Black Tartarian. It must be remembered that these oats were grown on plots and not in large fields of each variety. The land on which they were grown, however, received no commercial fertilizers, but had an application of farmyard manure at the rate of twenty tons, which is about equal to twelve good-sized loads per acre, once every four years. Besides this, the land received one green crop plowed under within the last ten years. In a four years' rotation the Oats usually followed a cultivated crop which had been manured.

In the average results for five years in growing thirty-three varieties of oats, the varieties which have given high results, other than those already mentioned in the previous paragraph, are the Vick's American Banner, Canadian Pride, Peerless, Irish Victor, Liberty, Mennonite, Michigan Wonder and New Zealand. Among those grown for less than five years, the following are the largest yielders: Ertragreichster, Yellow Russian, The Great American, and the New Golden Cluster.

Seventy-eight varieties of oats were under experiment in 1904, and the results from the plots show that the following varieties produced the greatest yield of grain per acre: American Banner, Peerless, New Zealand, Irish Victor, Michigan Wonder, German Rust Proof, Black Gotham, Liberty, and The Great American. In weight of grain, only four varieties went as high as forty pounds per measured bushel, viz., Early Dawson, White Superior Scotch, Zhelannie, and Tobolsk.

In some localities, the oat crop lodges very badly before it is cut. In these sections, it is very important to obtain a variety which is very stiff in the straw and not so likely to lodge as some of the older varieties. According to the results of our experiments, the Tartar King and the Storm King are among the very stiffest straw varieties. These are apt to stand up where some of the other varieties will become badly lodged. We notice, however, that in extreme cases, where the Tartar King variety is grown and where it does become lodged, it usually lies very flat on the ground. The Storm King was grown in 1904 for the first time, and our experience, therefore, with this variety is still very limited. A variety obtained under the name of Canadian King is very similar to the Storm King, and may possibly be another name for the same variety.

According to the results of quite extensive experimental work at the College, we find that by growing oats and barley together a larger yield of grain can be obtained than from either one grown separately. In order to grow two grains together, however, it is important to select such varieties as will mature at about the same time. As nearly all varieties of oats are considerably later in maturing than most of the varieties of barley, it is important to select some very early variety of oats to use in combination with a six-rowed barley. The follow-

in table gives the average results in number of days from seeding until maturity, strength of straw, weight per measured bushel, and average yield per acre of some of the very earliest oats we have grown at the College within the past three years:

Varieties.	Number of days in reaching maturity.	Per cent. of crops lodged.	Average results for three years.		
			Weight per measured bushel.	Yield per acre.	
				Straw.	Grain.
			lbs.	Tons.	Bushels.
Daubeney	98	5	34.5	2.3	95.7
Alaska	97	15	34.5	2.5	95.3
Black Mesdag	97	7	33.4	2.6	94.1
Early White Pearl	100	13	34.9	3.0	91.6
Early Champion	99	5	34.8	2.4	88.3
Early Ripe	95	22	28.7	2.3	81.3

It will be seen that the Daubeney variety is one of great promise, when the complete results are taken into consideration. The Daubeney variety grows a good length of straw, stand up very well, has a spreading head and white grain, and the grain is very thin in the hull.

CONTINUOUS SELECTION OF SEED OATS FOR TWELVE YEARS IN SUCCESSION. For twelve years in succession, an experiment has been conducted in breeding oats by means of the selection of the seed. The selections made were large, plump, well-developed seeds: light-weighting and light-colored seeds; and also seeds from which the hulls had been removed by the separator. The test was commenced in the spring of ~~1903~~ 1903, by selecting seed from the general crop of the Joannette Black oats of the previous year. The selection made in each of the following years has been from the product of the selected seed of the previous year. The number of grains used on each plot was carefully counted and an equal number was used of each selection in each year. As the selection for this experiment has been continuous, selecting the seed each year from the crop produced in the year previous, the average results are of but little value, but the final results are interesting, valuable, and quite suggestive. In the crop produced in 1904, it was found that the large plump seed produced 94.1 bushels; the light seed, 68 bushels; and the hulled seed, 91.6 bushels per acre. As only the best quality of seed becomes hulled, we find that the oats from which the hulls had been removed gave nearly as good results as the carefully selected, large, plump seed from which the hulls had not been removed in the process of threshing. In weight per measured bushel, the crop produced from the large plump seed weighed 34.5 pounds; from the light seed, 24 pounds, and from the hulled seed, 33.1 pounds. The difference, therefore, between the large, plump, well-developed seeds and the light-weighting and light-colored seeds is very marked, and shows the great importance of sowing the former and discarding the latter. It is interesting to notice that the crop producing

from the large plump seed required only 1390 grains to weigh an ounce; while the crop produced from the light seed required 2095 grains to make the same weight.

TREATMENT FOR SMUT IN OATS. Two varieties of oats were selected in the spring of 1902, 1903, and again in 1904, and uniform samples of each variety were submitted to several treatments, with the object of killing the spores of smut adhering to the grain. The various treatments were as follows:

(1). *Immersion in Diluted Formalin.* The solution of formalin used for the immersion process was made by pouring one-half pint of the formalin into 21 gallons of water, and the seed oats were immersed in the solution for twenty minutes.

(2). *Sprinkling with Diluted Formalin.* One-half pint of formalin was poured into 5 gallons of water. The oats were then sprinkled with this solution and carefully stirred until the grain was thoroughly moistened.

(3). *Immersion in Hot Water.* For this treatment, the grain was placed in a bag, which was then immersed in water at about 115 degrees F. Soon afterwards it was placed in water which was kept at a temperature of between 130 degrees and 135 degrees F. The grain was occasionally stirred, and was allowed to remain in the water for a period of fifteen minutes. It was then spread out on a clean floor to dry, where it was stirred occasionally.

(4). *Immersion in Bluestone Solution for Twelve Hours.* In this treatment, the bluestone solution was made by dissolving one pound of bluestone in 25 gallons of water, and the oats were immersed in this solution for a period of twelve hours.

(5). *Immersion in Bluestone Solution for Five Minutes.* For this treatment, a strong solution was made by dissolving one pound of Copper Sulphate (Bluestone) in one gallon of water, and then immersing the oats in the solution for a period of five minutes.

(6). *Immersion in Potassium Sulphide Solution.* The potassium sulphide treatment consisted in soaking the seed for two hours in a solution made by dissolving eight pounds of potassium sulphide in 50 gallons of water.

(7). *Sprinkling with Bluestone Solution.* This solution was made by dissolving one pound of bluestone in 10 gallons of water, which was used for sprinkling over the oats until they were thoroughly moistened after being carefully stirred.

(8). *Untreated.* One sample of oats of each variety was left untreated in order that the influence of the various treatments might be observed.

It will be seen that eight lots of each variety of oats were used in the experiment each year. After the treatments had been completed a few hours the oats were carefully sown on separate plots, each of which was exactly one rod square. When the oats were coming into head, they were examined frequently and all smutted heads removed

and carefully counted. The following table gives the results in the percentage of smutted heads of oats in the average of the two tests in 1904, and also of the six tests in the three years during which this experiment has been conducted:

Treatments.	Percentage of Smutted Heads.	
	1904.	Average of 3 years.
Immersion in diluted formalin	.0	.0
Sprinkling with diluted formalin	.0	.0
Immersion in hot water	.0	.0
Immersion in bluestone solution for twelve hours	.0	.2
Immersion in bluestone solution for five minutes	.7	1.1
Immersion in potassium sulphide solution	.3	1.3
Sprinkling with bluestone solution	1.4	1.4
Untreated	11.6	7.0

The results here presented are certainly worthy of careful consideration. It will be seen that in 1904 untreated seed had about 12 per cent. of smutted heads in the resulting crop. In the average results for the three years, there was a loss of seven per cent. caused by the injury by smut from the untreated seed. In comparison with this, we have the excellent results from the treatments with formalin and hot water. In the treatment with the stronger solution of formalin, however, which was sprinkled on the grain, the yield of oats per acre was less in 1904 in the case of each variety, as compared with other treatments. Taking everything into consideration, the immersion of the oats for twenty minutes in diluted formalin, made by using one-half pint of formalin with 21 gallons of water, has given excellent results. The treatment is easily performed, comparatively cheap, and very effectual.

INFLUENCE ON THE NURSE CROP FROM SEEDING DOWN WITH TIMOTHY AND CLOVER. In 1904 an experiment was conducted for the first time, with the object of ascertaining whether any direct advantage or disadvantage would result to a grain crop by sowing seed of Red Clover, Alsike Clover, and Timothy at the time of sowing the grain. No less than thirty-two plots were used for this experiment. The Siberian and the Joannette varieties of oats were each used on one-half the plots. Eight plots were seeded with Common Red Clover, eight with Alsike Clover, eight with Timothy, and eight plots were left without either grass or clover seed. The oats, Timothy seed, and clover seed germinated splendidly and the crops were very satisfactory in every case. In averaging the results, it is found that there is exactly 1.14 per cent. more oats where no grass or clover were sown than where the Timothy Alsike, and Red Clover were grown with the oats. It will therefore

be seen, from the results of this experiment, that the practice of sowing grass and clover seed with the grain exerts but a very slight influence upon the yield of the grain crop.

SMUTTED OATS, ONE, TWO, THREE AND FOUR YEARS OLD FOR SEED PURPOSES. An experiment was conducted in 1904 for the first time, in order to ascertain whether the spores of smut on oats would be vital when two, three, or four years of age. For this experiment, the Black Tartarian and Daubeney varieties of oats were selected. Seed of each variety was taken from the crops of 1900, 1901, 1902, and 1903, and was sown on separate plots in the experimental grounds in the spring of 1904. These plots were watched very carefully, and, as any smutted heads appeared, they were removed from the plots and counted. The results show that as the seed increased in age there was a decrease in the yield of oats per acre and an increase in the percentage of smutted heads. Further work will likely be carried out along this line.

WINTER OATS. Winter oats have been sown in our Experimental Department in the autumn of the year on several occasions, but the crop has always become badly winter killed. In the autumn of 1903, we sowed two varieties of winter oats, which made a good growth in the fall of the year but which were completely killed out during the winter. We have never yet been successful in getting a variety of winter oats which would withstand the severe winter weather at the College.

WHEAT.

The wheat plant appears to have been known and valued from earliest times. It will thrive successfully in a great range of climate and the inhabitants of many countries enjoy the advantages of its cultivation. According to most authorities, there are in all seven types of wheat, and to one or the other of these types, or species, all varieties belong. The seven types of wheat are as follows:

- (1) Common, fine, or soft wheat (*Triticum vulgare*).
- (2) Turgid, or toulard wheat (*T. turgidum*).
- (3) Hard or flinty wheat (*T. durum*).
- (4) Polish wheat (*T. polonicum*).
- (5) Spelt (*T. spelta*).
- (6) Emmer or starch wheat (*T. dicoccum*).
- (7) One-grained wheat (*T. monococcum*).

Representatives of these different classes have been grown in our experimental grounds, although practically nothing is known throughout the Province about varieties of either turgid or one-rowed wheat. Considerable, however, has been said in reference to representatives of each of the other classes. Nearly all of the varieties of both spring and winter wheat which are grown in Ontario belong to type No. 1, the common wheat. Some of the best known representatives of other types are as follows: Wild Goose spring wheat, Medeah spring wheat, Algiers spring wheat, Polish spring wheat, Miracle winter wheat, etc. For the sake of convenience, we have arranged our report of varieties

of wheat as follows: Varieties of winter wheat for flour production, varieties of spring wheat for the production of macaroni, and varieties of spring wheat for feeding purposes.

VARIETIES OF WINTER WHEAT FOR FLOUR PRODUCTION. The past year has been an unfavorable one for winter wheat production in Ontario, According to the last report of the Bureau of Industries, we learn that no less than 189,274 acres, or nearly 24 per cent., of the area sown to winter wheat last autumn, was plowed in the spring of 1904. Some of the varieties in the experimental grounds at the College survived the winter in good condition; while some of the tender varieties were considerably winter killed.

Within the past fifteen years, about two hundred varieties of winter wheat have been grown at the College. The most of these have been grown for at least five years in succession. The highest yielding varieties for the past five years, including 1904, have produced the following average number of pounds of grain per measured bushel, and of bushels of grain per acre: Dawson's Golden Chaff, 59.9 lbs., 59.8 bus.; Imperial Amber, 61.2 lbs., 58 bus.; Prize Taker, 59.8 lbs., 57.6 bus.; Silver Dollar, 59.7 lbs., 57 bus.; Buda Pesth, 61.4 lbs., 55.4 bus.; Rudy, 61.1 lbs., 55.4 bus.; Forty-fold, 59.1 lbs., 55.4 bus.; and Egyptian Amber, 61.4 lbs., 55.2 bushels. The greatest yielders among seventy-two varieties grown in the past year, however, were the Imperial Amber, 41.3 bus.; Buda Pesth, 40 bus.; Crimean Red, 39.9 bus.; Rudy, 38.1 bus.; Tasmania Red, 36 bus.; Dawson's Golden Chaff, 35.7 bus.; and Egyptian Amber, 35 bushels per acre. The weight per measured bushel for this season has been exceptionally light, as can be seen from the following: Tasmania Red, 58.6 lbs.; Imperial Amber, 57.6 lbs.; Dawson's Golden Chaff, 55.7 lbs.; Turkey Red, 55.5 lbs.; and Early Genessee Giant, 52.3 pounds. The Dawson's Golden Chaff possessed the stiffest straw and the Red Hussar the weakest straw in 1904. All varieties rusted more or less in 1904, the Ironclad, Tasmania Red, and Pride of America being the freest. The Hessian fly did only a small amount of damage the past year.

VARIETIES OF SPRING WHEAT FOR FLOUR PRODUCTION. Spring wheat throughout Ontario seemed to give promising results until about the time of ripening, when the rust attacked the straw considerably, and the weather conditions seemed unfavorable for the production of a plump sample. In some sections the spring wheat was an utter failure. In the experiments at the College, most of the varieties gave a fair yield per acre, but the quality was unusually poor, as nearly all of the varieties came considerably under the standard in weight per measured bushel.

Eleven varieties of flour producing spring wheats have been grown in the Experimental Department under similar conditions for six years in succession. In the average results for the six years, the varieties here referred to have given the following yields per acre: Pringle's Champion, 35.1 bus.; Saxonka, 34.8 bus.; Red Fife, 34.5 bus.; Color-

ado, 34.1 bus.; Blue Democrat, 34 bus.; Preston, 33.5 bus.; White Russian, 33.3 bus.; Wellman's Fife, 33.1 bus.; Red Fern, 33.1 bus.; Herison Bearded, 32.2 bus.; and Seven Headed, 30.1 bushels. Of the newer varieties which have been under experiment for only three years, the following are among the heaviest yielders: Kolben, 28.9 bushels, and Climax, 25.4 bushels

VARIETIES OF SPRING WHEAT SUITABLE FOR THE PRODUCTION OF MACARONI. Those varieties of spring wheat suitable for the production of macaroni mostly belong to type No. 3, viz., the hard or flinty wheat (*T. durum*). Some seven varieties in all have been grown at the College for several years in succession. The average results of six years' experiments with six of these varieties are as follows:

Varieties.	Weight per measured bushel.	Yield of straw per acre.	Yield of grain per acre.
	Lbs.	Tons.	Bushels.
Wild Goose	62.0	2.3	42.1
Medeah	59.8	2.4	38.6
Sorentina	59.2	2.3	38.4
Bart Tremenia	60.1	2.3	37.3
Algiers	58.8	2.3	36.6
Ontario	55.1	2.9	29.0

It will be seen from the average results of the macaroni wheats for six years, that the Wild Goose variety has given the largest yield of grain per acre, and also the heaviest weight of grain per measured bushel. In the average results for 1904, the greatest yields were produced by the Wild Goose and the Medeah, and the lowest by the Ontario variety.

Another wheat which has been grown more or less in Egypt, Algiers, Spain, Italy, and Eastern Europe, and to a very limited extent in America, and which has been used to a greater or less extent for the manufacture of macaroni, is the representative of the species *Triticum polonicum*, and is known under such names as Polish Wheat, Corn Wheat, Colorado Giant Rye, etc. Many extravagant claims have been made for this grain in the Western States within the last two years. The straw of this variety is of medium length and is almost solid. The heads are large, and the outer chaff projects beyond the inner chaff in a peculiar manner. The grains are very hard and are about one and a half times as large as those of the Wild Goose spring wheat. We first grew the Polish wheat at the College in 1889. Careful tests of its comparative results, along with other varieties, have been made for at least ten years. In the average of the ten years' experiments, we find that the yield per acre of the Polish wheat is 22.1 bushels, and that of the Wild Goose 36.3 bushels per acre. The Wild Goose variety, therefore, gave an average yield of about 60 per cent. more than that of the Polish wheat.

According to the results of the experiments made with different macaroni wheats at the College, it will be seen that the Wild Goose variety has given the most satisfactory results in yield of grain per acre. This variety is exceedingly hard and contains a large amount of gluten. The flour produces bread of excellent quality but which is of a yellowish color, which gives it an unattractive appearance. As the wheat is very hard, it is difficult to grind, but many millers are now using a limited quantity of the flour of the Wild Goose variety to strengthen that of some of the softer kinds of both winter and spring wheats. A considerable amount of the Wild Goose spring wheat has been shipped to Italy, and to other parts of Europe, for the manufacture of macaroni, and it is largely that demand which has increased the price of the Wild Goose spring wheat in Ontario during recent years.

VARIETIES OF SPRING WHEAT FOR FEEDING PURPOSES. Emmer and Spelt are two distinct types of wheat, there being a number of varieties belonging to each type. The grain of both the Emmer and the Spelt is tightly enclosed within the chaff, from which only a small portion is separated in the process of threshing. The heads of Emmer are short and compact, and are nearly always bearded; while those of Spelt are long, narrow, open, and are usually bald. The spikelets of Emmer overlap each other like shingles on a roof, which thus makes the head close, smooth, and regular. The portion of the stem adhering to the spikelets after threshing is much smaller and more pointed in the Emmer than in the Spelt. The spikelets of the Emmer are flattened on the inner side, while those of the Spelt are arched. The grain of the former is much harder, and the chaff much softer, than that of the latter. Emmer is considered a very hardy plant, being much superior to Spelt in this respect. Three varieties of Emmer and ten varieties of Spelt have been grown in the Experimental Department of the College. The following table gives the average of three years' results of each of three of the principal varieties of Emmer and four of the principal varieties of Spelt which were tested in 1902, 1903, and 1904:

Classes of Crop.	Varieties.	Average results for three years.					
		Percentage of			Pounds per bushel 2 years.	Yield per acre.	
		Rust.	Crop lodged.	Hull with grain.		Tons of straw.	Pounds of grain.
Emmer.....	Common.....	3	36	22	36.8	2.7	3,467
	Iowa.....	2	36	21	37.3	2.4	3,248
	Russian.....	2	34	22	36.3	2.3	3,204
Spelt.....	Red.....	20	6	32	25.4	2.2	2,364
	Alstroum.....	20	4	33	24.4	2.0	2,164
	White.....	19	5	34	23.7	1.7	1,895
	Dasyanthum...	23	25	40	22.6	2.1	1,637

It will be seen from the foregoing table that all the varieties of Emmer have given decidedly better results than the best varieties of Spelt which we have grown. In the co-operative experiments throughout Ontario in 1901, 1902, 1903, and 1904, Emmer produced a larger average yield of grain per acre than the best variety of oats or the best variety of barley which was distributed. It is quite probable that the Emmer will be grown considerably throughout Ontario for the production of good, clean straw and a large yield of grain, to be used as a food for live stock. For feeding purposes, the grain and the surrounding chaff are usually ground together in the same manner as oats are ground into meal.

SOWING EMMER AND SPELT ON DIFFERENT DATES. Both Emmer and Spelt were sown on eight different dates in the spring of 1903, and again in the spring of 1904, starting on April 2nd in 1903 and on April 22nd in 1904, and finishing on May 21st in 1903 and on June 10th in 1904, and allowing one week between each two dates of seeding. The average results of the experiment for two years are presented in tabulated form.

Dates of Seeding.	Average results for two years.					
	Lbs. per measured bushel.		Tons of straw per acre.		Lbs. of grain per acre.	
	Spelt.	Emmer.	Spelt.	Emmer.	Spelt.	Emmer.
1st	28.0	38.3	1.8	2.1	2,393	2,058
2nd	26.1	38.0	1.5	2.1	1,993	3,038
3rd	25.6	38.0	1.7	1.9	1,829	2,827
4th	24.4	37.6	1.6	2.1	1,354	3,010
5th	23.9	37.6	1.6	2.2	1,277	3,094
6th	23.2	37.2	1.7	2.4	1,010	2,836
7th	22.1	36.8	1.5	2.8	795	2,782
8th	24.1	35.5	1.6	2.1	577	2,332

The average results of the experiment in sowing Emmer and Spelt in 1903 and 1904, on the average dates of April 12th, April 19th, April 26th, May 3rd, May 10th, May 17th, May 24th, and May 31st, show that decidedly the best yield of Spelt was obtained from the first seeding; while there was but little difference in the yield per acre of the Emmer sown on the 1st, 2nd, 4th, and 5th dates. The figures indicate the great importance of sowing Spelt as early in the spring as the land is warm and dry enough to work to good advantage. In the case of Emmer, however, comparatively late seeding gives about as good results as the seeding which takes place at an early date. The figures of this report, as well as those in the report of the varieties of Emmer and Spelt given previously, show very forcibly the superiority of the Emmer over the Spelt as a grain producer in this section of the Province.

MATURITY OF WINTER WHEAT FOR SEED PURPOSES. Seed taken from wheat which was allowed to become very ripe before it was cut produced a greater yield of both grain and straw and a heavier weight of grain per measured bushel than that produced from wheat which was cut at any one of four earlier stages of maturity, according to the average results of fourteen separate tests.

SELECTION OF SEED. Selections of seed made from two varieties of winter wheat and tested for six years produced average annual results in bushels of grain per acre, tons of straw per acre, and pounds per measured bushel as follows: Large plump seed, 46.9 bushels, 2.6 tons, and 59.4 pounds; Small plump seed—40.4 bushels, 2.2 tons, and 59.2 pounds; Shrunken seed—39.1 bushels, 2.1 tons, and 59.1 pounds; and Broken seed—9.3 bushels, .6 tons, and 54.2 pounds, respectively.

QUALITY OF WINTER WHEAT TO SOW. The average yield, less the amount of seed used, from sowing one bushel, one and one-half bushels, and two bushels of each of two varieties of winter wheat per acre in each of six years, have been 39.7 bushels, 42.3 bushels, and 42 4 bushels per acre, respectively.

SOUTHERN AND NORTHERN GROWN WINTER WHEAT SEED. Seed wheat grown a thousand miles south of Guelph gave practically the same results as Ontario grown seed in the average experiments of two years.

DATES OF SOWING WINTER WHEAT. Winter wheat sown at the College during the first ten days of September in each of nine years has yielded 5.2 bushels per acre more than that sown from the 16th to the 20th of September.

METHODS OF SOWING WINTER WHEAT. The average results of sixteen experiments, covering a period of eight years, show that on well cultivated land winter wheat which was drilled in with a machine, and that which was sown broadcast by hand, gave practically the same yields of grain per acre.

GREEN MANURING FOR WINTER WHEAT. Land on which field peas were used as a green manure yielded 6.5 bushels of wheat per acre more than land on which buckwheat was used as a green manure, and 2.3 bushels per acre more than land which was worked as a bare fallow, in the average of eight separate tests.

TREATMENT OF WINTER WHEAT FOR SMUT. In each of five years, experiments have been conducted in treating winter wheat in different ways to kill the stinking smut, and the results have been very satisfactory. In the autumn of 1903, seven different treatments were made with each of two varieties of wheat. In the crop of the present year, the wheat produced from treated seed had no smut, and that from untreated seed had 3.6 per cent. of smutted heads. The treatment which proved very simple, cheap and effective was the immersion of the seed wheat for twenty minutes in a solution made by adding one pint of formaldehyde (formalin) to forty-two gallons of water. The past year was the first time that we used the formalin treatment as a part of this

experiment. In the average of five years' experiments, it was found that untreated wheat had 368 smut balls per pound of wheat; while that treated with potassium sulphide, bluestone, and hot water had only nine, two, and one smut balls, respectively. The copper sulphate (bluestone) treatment consisted in immersing the seed twelve hours in a solution made by dissolving one pound of copper sulphate in twenty-four gallons of water, and then immersing the seed for five minutes in lime water made by slacking one pound of lime in ten gallons of water. The hot water treatment consisted in immersing the wheat for fifteen minutes in water at 132 degrees F. After each treatment, the grain was spread out and stirred occasionally until dry enough to sow.

RYE.

Rye can sometimes be grown advantageously in those districts in which the soil is unsuited for other cereal crops. It is the characteristic food-grain of middle and northern Europe, and is used extensively by fully one-third of the population of Europe.

WINTER RYE. Several varieties of winter rye have been grown in our experimental plots for a number of years with good success. In the autumn of 1903, five varieties were sown in the same section of the field as the winter wheat. They all came through the winter well, surpassing many of the varieties of winter wheat in this respect. In five years' experiments with two varieties of winter rye, we find that the Mammoth gave an average yield of 60.5, and the Common variety of 57.8 bushels per acre. These are very large yields, showing that winter rye is a very hardy crop, withstanding the severity of even some of the severe winters which we have had within the past five years. In the experiments for 1904, the Mammoth gave 56.4; and the Common, 55.5; the Thousand-fold, 54.8; and the Washington variety, 51.8 bushels of grain per acre. It will therefore be seen that the Mammoth variety produced a greater yield per acre in 1904, and in the average of the past five years.

SPRING RYE. Four varieties of spring rye were grown in our experimental plots in the past season, the following being the results in yield of grain per acre: Dakota Mammoth, 34.9 bus.; Prolific Spring, 26.7 bus.; Common, 24.7 bus.; and Saatroggen, 24.3 bushels. Two of these varieties have been grown for seven years in succession, and the average results have been as follows: Dakota Mammoth, 38.8 bushels, and Prolific Spring, 35.1 bushels per acre. It will therefore be seen that among the spring varieties, the Dakota Mammoth has given very satisfactory results in yield of grain per acre. This variety has also produced slightly the heaviest weighing grain per measured bushel, the average for seven years being 57.4 pounds.

BUCKWHEAT.

Buckwheat is a native of Northern Asia, and has been grown as a cultivated crop for fully one thousand years. It grows and produces

a marketable crop on very poor soil, and it thrives admirably in cold climates. It is mainly grown for the production of grain, but it is also grown to a limited extent for soiling purposes and for plowing under as a green manure.

We have grown eight varieties of buckwheat in our experimental grounds within the past few years. Three varieties, namely, the Japanese, the Silver Hull, and the Common Grey, have each been grown in our trial grounds for eight years in succession. In the average results for the eight years, we find that the Silver Hull variety takes the lead with 20.2 bushels per acre. This, however, is closely followed by the Japanese variety, which produced a yield of 19.7 bushels per acre. The Common Grey, under similar conditions, gave only 16.6 bushels per acre. The last two or three years have been very unfavorable for the Japanese variety. According to the experiments conducted both at the College and throughout Ontario, the Japanese buckwheat appears to give the best results in seasons which are comparatively warm and dry; and the Silver Hull variety in cool, damp seasons such as we have had in 1902, 1903, and 1904. The results for the last year are quite different from the average of the last eight years, the following being the yield per acre of each variety: Japanese, 11.7 bushels; Silver Hull, 37.5 bushels; and Common Grey, 20.3 bushels per acre. Therefore, in the past season, the Silver Hull variety has yielded more than three times as much as the Japanese buckwheat. The Silver Hull variety possesses very plump grain, which is thin in the hull and weighs well per measured bushel.

FIELD PEAS.

The common field pea is a leguminous plant and a native of Italy. It has been in cultivation many hundred years, and is chiefly grown for its grain. It is also used in mixing with oats for the production of green fodder or hay. For soiling purposes, it produces a large yield of very nutritious food, but when fed alone is not generally relished by farm stock. The seed is exceptionally rich and is of great value for using with other grain in fattening cattle and hogs. The straw is used extensively as a food for sheep, and is sometimes mixed with other coarse fodder for feeding to dairy cows. Field peas are sometimes used as a green manure with very excellent satisfaction.

Owing to the ravages of the pea weevil (*Bruchus pisorum*), frequently called the pea bug, the acreage of peas has been greatly reduced in Ontario during the past six or seven years. In many sections of the southwestern part of the Province, the farmers have given up the growing of peas entirely for a time, owing to the great damage caused by the pea weevil. As the acreage has been reduced to such a large extent, we would very strongly advise any persons who grow peas in the southwestern part of Ontario in 1905 to cut the peas a little on the green side, then cure and thresh them as soon as possible,

and immediately treat them with carbon bisulphide. Within a period of seven years, about thirty different treatments of peas were made in the Experimental Department for the destruction of the pea weevil. In handling the crop, care was taken throughout to pull the peas at the proper time, to haul them to the barn when dry, and to thresh them as soon as possible. Immediately after threshing, the peas were put into cotton or jute bags. As soon as thirty bushels of peas were threshed, they were placed in a fumigation box for treatment. One pound of carbon bisulphide was poured into three flat pans, which were placed on the top of the peas; the cover was then put on the box and weighted with heavy stones. After forty-eight hours the cover was removed and the box ventilated. The pans had become dry, as the liquid had changed into a gas, which, being much heavier than air, had sunk down amongst the peas penetrating them and killing the weevils. The quantity of carbon bisulphide used by us was larger than that usually recommended, as a pound or a pound and a half is generally considered sufficient for one hundred bushels of peas, but we wished to be on the safe side. In practically all cases the weevils were destroyed at the first treatment, no matter whether they were in the larva form, in the pupa stage, or had become fully developed. The treatment can be made in any comparatively air-tight receptacle, whether a barrel, box, or specially made fumigation house.

Carbon bisulphide is a colorless or slightly yellowish liquid, one-fourth heavier than water. It is extremely volatile, i. e., it evaporates very rapidly when exposed to the air, and when pure will not injure or stain the finest goods. The commercial liquid has an acrid taste, and an odor like that of rotten eggs. The vapor is more than two and a half times as heavy as air. Carbon bisulphide may be purchased in small quantities from any druggist at about 30 cents per pound, or 40 cents per pint. For large quantities, better rates can be given by the druggist. The gas, or vapor, which comes from carbon bisulphide is not only combustible, but it is very explosive when mixed with air. Great care should therefore be taken to treat the peas in the daytime only, for a light or a flame of any kind brought near the liquid may cause a serious explosion; and smoking near it should be positively prohibited. Moreover, the vapor should not be inhaled, as it is very injurious, even a small portion causing headache, giddiness, and nausea. The treatment with carbon bisulphide should be made in boxes, barrels, or "bug houses," located some distance from the insured buildings on the farm.

With the strict observance of the preceding precautions, no one should hesitate to use the carbon bisulphide. As a matter of fact, we have never heard of any bad results following its use in the treatment of peas. This happy condition of things may be explained when we say that all who used the liquid were wise enough to be cautious. There is, moreover, no danger that the vapor will injure the peas or render them unsafe as a food. Experiments have shown that the liquid can

even be poured upon articles of food, and, after thorough exposure to the air, not a trace of it will remain.

There is as yet but little trouble from the pea weevil in the extreme eastern and northern portions of the Province, where peas can still be grown to good advantage. Although we have not made comparative tests of different varieties of peas in our experimental grounds during the past two years, a reference might here be made to the results of former experiments. Fully one hundred varieties of field peas have been grown in our experimental plots within the past fifteen years. For a very rich soil, the White Wonder gave the greatest yield of grain per acre; for a soil of medium quality, the Early Britain gave a very high yield, and the New Canadian Beauty gave a moderately high yield of seed of excellent quality; and for poorer soils, the Prussian Blue and the Tall White Marrowfat, which are both very long strawed varieties, gave excellent results.

Although we have mentioned previously that no comparative experiments of different varieties of field peas have been conducted during the past two years, the Early Britain variety was grown and ripened in 1904, and was carefully examined in order to ascertain the ravages of the pea weevil. As determinations regarding the percentage of weevilly peas of this variety have been made since 1894, the percentage of crop infested with the weevils each year gives us some information regarding the ravages of this pest in this section of the Province. The following gives the percentage of weevilly peas of the Early Britain variety for each of the eight years: 1894, 2; 1895, 7; 1896, 11; 1897, 34; 1898, 49; 1900, 75; 1901, 96; and 1904, 61 per cent. It will therefore be seen that the damage caused by the pea weevil in 1904 was only about two-thirds as great as it was three years ago. As the farmers in the vicinity of Guelph have stopped growing peas to a considerable extent within the past two years, the ravages of the pea weevil seem to be somewhat reduced.

FIELD BEANS.

Field beans are not grown very extensively throughout Ontario, except in the southwestern part, and especially in the counties of Essex and Kent. Fourteen varieties of beans were under experiment in our trial grounds at the College in 1904. The yields were comparatively low this season, probably due to the cold, wet weather in this part of the Province. The seven highest yielding varieties in the past season were: New Prize Winner, 17.4 bushels; Schofield Pea, 16.6 bushels; White Wonder, 15.3 bushels; Small White Field, 15.3 bushels; Burlingame Medium, 14.8 bushels; the Pearce's Improved Tree, 14.8 bushels per acre. In the average results for eight years of thirteen varieties of beans, which have been grown for that length of time, we find that those varieties which gave the greatest yields per acre were the White Wonder, 21.8 bushels; Pearce's Improved Tree, 21.3 bushels; Burlingame Medium, 20.8

bushels; Medium or Navy, 20.7 bushels; and Schofield Pea, 20.5 bushels per acre. In average weight per measured bushel for eight years, there was a variation from 57 pounds for the Large White Haricots to 65.7 pounds for the Snowflake variety. Twelve out of the thirteen varieties, however, gave upwards of 62 pounds per measured bushel in the average of eight years' experiments.

SOY, SOJA, OR JAPANESE BEANS.

Many of the varieties of Soy beans require too long a season to give satisfactory results in Ontario. As the result of experiments conducted for a series of years, however, we have found the Early Yellow variety to give good satisfaction as a grain producer, and the Medium Green variety as a fodder crop. We believe that as the Medium Green variety becomes better known, it will be grown for the purpose of cutting green and mixing with corn when filling the soil. We also believe that the Early Yellow variety can be grown quite successfully for grain production on many farms of Ontario. The grain is exceedingly rich, containing more protein than any of the ordinary farm crops grown in Ontario. A small quantity of the Soy beans, ground and mixed with other meal, will increase the quality of the meal considerably. Owing of the unfavorable weather conditions for the Soy beans in 1904, the crop was not as satisfactory as usual. We generally get about 1,200 pounds of grain per acre, but the best yielding variety of Soy beans in 1904 produced only 880 pounds of the ripened seed per acre.

HORSE BEANS.

The Horse bean is a coarse, rank-growing annual legume which is used quite extensively in Europe as a forage plant. There are several named varieties of horse beans, a number of which have been grown at the College. They have been under test in the Experimental Department for practically each season during the past fifteen years. In most seasons, they give very poor results. The yield of ripe seed in 1904 was only 200 pounds per acre. On the whole, the Horse beans seem to be unsuited for general cultivation throughout Ontario.

GRASS PEAS.

The Grass pea is a leguminous plant, which produces long, flat vines; slender leaves; white blossoms; medium-sized pods; and hard, angular, white, or greenish white, grains. It is entirely proof against the attacks of the pea weevil. In many respects, it resembles the Bitter Vetch (*Lathyrus sativus*) of Europe, which, however, has blue flowers and brown seeds. It also appears to be free from the poisonous principle which the Bitter Vetch is said to possess. This is borne out by the extensive and satisfactory use of the Grass peas as a food for farm stock.

In the average results of tests made for a period of seven years, it was found that the annual yield of grain was 25.7 bushels, and the yield of straw 2.2 tons per acre. During the last two or three years,

however, the seasons have been very unfavorable for the growth of the Grass peas, as they have for practically all kinds of leguminous crops. The yield per acre of Grass peas at the College in 1904 was only 992 lbs., or about 16 1-2 bushels per acre.

COW PEAS.

The Cow peas, which thrive so admirably in the southern States, require a comparatively long season from the time they are sown until they reach maturity. We have tested a large number of varieties, no less than ten being under experiment in 1904. We have as yet been unable to secure any varieties of Cow peas which have given satisfactory results at the College.

HAIRY VETCHES FOR SEED.

For four years in succession, Hairy vetches have been sown in the autumn and ripened in the following year, with the result that an average of 8.6 bushels of seed per acre has been obtained. The vetches sown in the autumn seem more productive of seed than those sown in the spring of the year. In past years, the Hairy vetch seed has been principally imported from Germany, and has usually cost about \$5.00 per bushel. The Hairy vetches produce a crop which seems specially useful as a pasture for farm stock, especially hogs; a cover crop in orchards; or a green manure for plowing under to enrich the soil.

ALFALA FOR SEED PRODUCTION.

For three years in succession, efforts have been made to produce Lucerne or Alfalfa seed in the experimental plots at the College. Owing, probably, to the unfavorable weather conditions, the yield of seed has been rather light in each of the three years.

CORN FOR GRAIN.

Owing to the cool, wet weather of the past season, corn for grain production gave a very poor crop. At the usual time of corn planting, the weather was cool and the land too wet to plant corn. Consequently, the seed was not planted until the early part of June. The growth throughout the season was rather slower than usual, and the first nipping frost occurred comparatively early this season, thus preventing the maturity of those varieties which usually ripen quite well at Guelph. The names of some of those varieties which gave the best satisfaction in 1904 are as follows, commencing with the best corn: King Phillip, Wisconsin Little Dent, Genessee Valley, Red Blazed, Extra Early Huron Dent, Farmers' Friend, Farmers' Surprise, University No. 13, Longfellow, Early Strawberry, Compton's Early, Golden Leneway Dent, Salzer's North Dakota, Tuscarora, and King of the Earlies. For the four years previous to 1904, the average yields per acre for the highest yielding varieties of corn for grain production were as follows: King Phillip, 58 bus.; Farmers' Friend, 54 bus.; Longfellow, 54 bus.;

Genessee Valley, 53 bus.; Canada Yellow, 48 bus.; Red Blazed, 47 bus.; Burlington Hybrid, 45 bus.; Salzer's North Dakota, 43 bus.; and Compton's Early, 42 bushels per acre. The King Phillip variety, which came at the top of the list in 1904, and also in the average of the four years previous, is a reddish flint variety which we have sent out in connection with the co-operative experiments over Ontario for the last two or three years. It has given very good satisfaction throughout the Province, giving the largest yield of grain per acre over Ontario in 1904.

SORGHUM FOR SEED.

Several varieties of sorghum, including different kinds of sugar cane, kaffir corn, broom corn, millo maize, etc., have been grown in the experimental grounds from year to year. Owing to the cool, backward season, however, none of the varieties ripened seed satisfactorily in 1904.

MILLET FOR SEED.

In the average results for five years, in testing fifteen varieties of millet for seed production, it is found that the Siberian Millet (47.5 bus.) Hungarian Grass (45.2 bus), and the California Millet (42.1 bus.), have been the heaviest yielders. These, however, have been quite closely followed by the German or Golden (38.8 bus.) and Early Harvest (38.7 bushels per acre). In comparison with these, it might be mentioned that the lowest yields were obtained from the White French, 14 bus.; Golden Wonder, 18.5 bus.; and the Red French, 19.3 bushels per acre. In the results of testing twenty-one varieties in 1904, we find the greatest yields produced by the Siberian Millet, Steel Trust Millet, Hungarian Grass, California Millet, German or Golden Millet, Early Harvest Millet, and Tamboy Millet.

SUNFLOWER SEED.

Seven varieties of sunflowers have been grown in the experimental grounds. Three of these varieties have now been grown for six years in succession. Allowing 20 pounds for the measured bushel, the average results for the six years are as follows: White Beauty, 68.7 bus.; Mammoth Russian, 65.5 bus.; and Black Beauty, 57.8 bushels per acre. It will thus be seen that all the varieties have produced heavy yields of seed per acre, and of the three leading varieties the White Beauty has given excellent satisfaction, producing an average yield of 1,374 pounds of seed per acre per annum.

FLAX SEED.

Four varieties of flax have been grown in the Experimental Department. The common variety has now been under experiment for nine years, the average yield per acre for the whole period being 13.5 bushels of grain. The yield of flax at the College has been very low in some seasons, and this has brought the average down to the figures

here given. In 1904 the common flax gave a yield of a little over 21 bushels of seed per acre.

SOWING SPRING GRAIN ON SIX DIFFERENT DATES.

Not only is it important that we give proper attention to the varieties of seed which we sow and to the careful selection of the seed, but it is also of very great importance to have the seed sown at **exactly** the right time in the spring of the year. In order to obtain some reliable and specific information regarding the actual results of sowing grains at different times in the spring of the year, an experiment has been conducted at the College in each of five years by sowing spring wheat, barley, oats, and peas, on each of six different dates in the spring. The experiment was conducted in duplicate each season. The first seeding took place when the land was warm enough and dry enough to work to good advantage. One week was allowed between each two seedings, unless unfavorable weather compelled a change of a day or two in the date of seeding. The average date of the first seeding was April 18th, and of the last seeding May 23rd. The average results of this experiment are reported in the accompanying table and are illustrated in the accompanying diagram. The average results for the five years in per cent. of rust, in weight of grain per measured bushel and in yield of straw and of grain per acre for each of the four classes of grain and for each of the six different dates of seeding of each kind of grain will be found in the table here given :

Class of crop.	Seeding.	Per cent. of rust, average 4 years.	Average results for five years.		
			Weight per measured bushel.	Yield of straw per acre.	Yield of grain per acre.
Spring wheat.....	1st seeding	4.5	60.1	1.22	21.9
	2nd "	5.5	59.6	1.13	19.2
	3rd "	5.3	59.0	.97	15.4
	4th "	7.8	58.9	.87	13.0
	5th "	8.5	56.5	.63	8.4
	6th "	11.3	54.0	.77	6.7
Barley	1st "	4.0	52.3	1.20	46.2
	2nd "	4.3	52.6	1.19	45.9
	3rd "	5.5	51.8	1.05	39.8
	4th "	6.3	50.3	1.04	37.1
	5th "	11.8	48.2	.94	27.6
	6th "	14.0	45.1	.85	18.4
Oats	1st "	10.8	33.9	2.00	75.2
	2nd "	15.8	34.5	2.10	76.0
	3rd "	19.3	32.1	1.83	64.2
	4th "	25.0	29.9	1.72	55.8
	5th "	25.3	27.3	1.56	45.2
	6th "	23.8	24.2	1.72	37.0
Peas			Per cent. of weevilly peas, average 2 years.		
	1st "	43.5	56.6	.92	25.4
	2nd "	56.0	56.6	1.07	28.8
	3rd "	49.0	57.6	1.10	28.5
	4th "	54.5	57.4	1.02	25.5
	5th "	59.5	57.0	.87	21.5
	6th "	57.0	57.0	.95	19.5

*Comparative Yields of Spring Grains Sown on Six Dates
One Week Apart
Commencing as Early as the Land was Dry Enough for Sowing.*

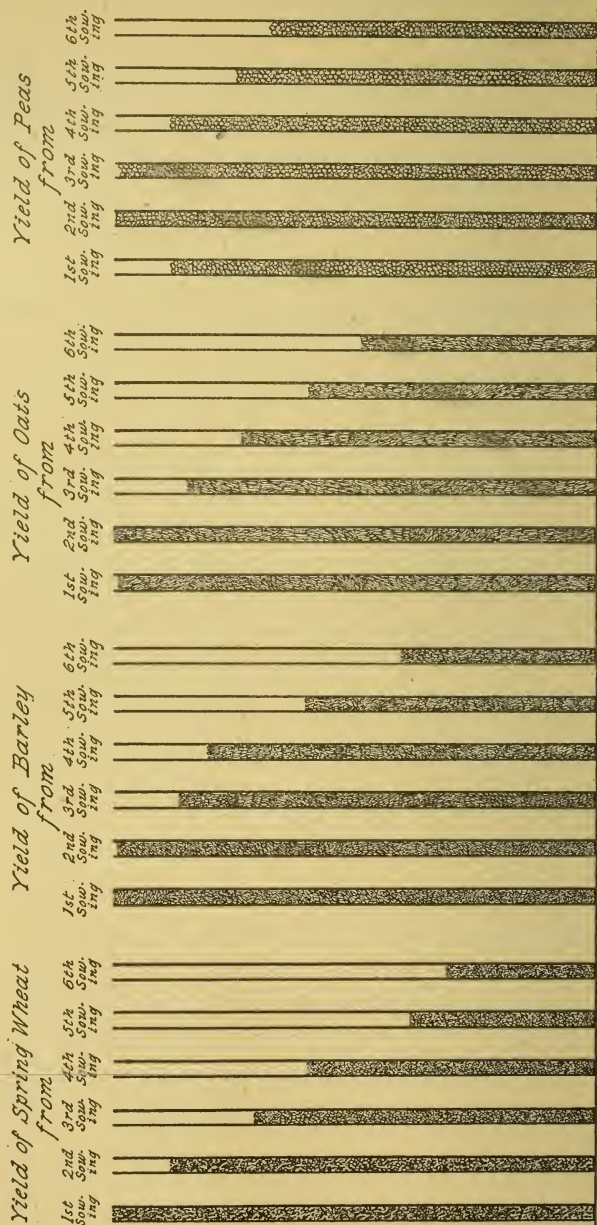


DIAGRAM ILLUSTRATING ONE OF THE CASES IN THE AGRICULTURAL MUSEUM AT THE COLLEGE, SHOWING THE AVERAGE OF FIVE YEARS' RESULTS IN SOWING SPRING GRAINS AT DIFFERENT DATES.

The results here presented show that the greatest average yield of grain per acre was produced by the spring wheat and by the barley from the first, and by the oats and the peas from the second date of seeding. This also holds good in regard to the straw per acre, with the single exception that in the case of peas the seed sown on the third date produced a little higher yield than that sown on the second date. In weight of grain per measured bushel, the first two dates of seeding are decidedly the best with spring wheat, barley, and oats, but in the case of peas the highest weights of grain per measured bushel were obtained from the third and fourth seedings. It will be observed that as the date of seeding was delayed the percentage of rust in the resulting crop was gradually increased, with only one slight exception. The results indicate the importance of sowing spring wheat, barley, oats, and peas in the order here given, starting with the spring wheat and finishing with the peas.

An exceedingly important lesson may be learned from the results of this experiment, which show that for every day's delay in the seeding after the first week was passed in which the seeding took place, there was an average decrease of 56 lbs. of oats, 53 lbs. of barley, 29 lbs. of spring wheat, and 23 lbs. of peas per acre.

GROWING GRAINS IN MIXTURES FOR THE PRODUCTION OF GRAIN AND STRAW.

Within the past fifteen years, a large amount of experimental work has been carried on in order to glean some reliable information regarding the comparative values of growing grains in combination in comparison with the growing of the same grains separately for the production of grain and straw. Some of the experiments have been completed, while others will need to be repeated in future seasons before the final conclusions can be drawn. The results of the experiments already conducted are very interesting and quite suggestive.

FOUR KINDS OF SPRING GRAIN GROWN SEPARATELY AND IN VARIOUS COMBINATIONS. For five years in succession, an experiment was conducted in growing peas, oats, barley, and wheat, separately, and in all the combinations which could be formed, having two, three, or four grains in each mixture. This formed an experiment of fifteen different crops, which were grown in comparison one with the other. The experiment was conducted in duplicate each year. The results go to show that the grain which was grown in mixtures produced larger yields per acre than the same kinds of grain grown separately in nearly the whole of the tests. Of the different mixtures used, the oats and barley gave the heaviest average yield of threshed grain per acre.

OATS AND BARLEY MIXED AND SOWN IN DIFFERENT PROPORTIONS. It was decided in the spring of 1899 to conduct an experiment in sowing nine different proportions of oats and barley in order to determine which mixture and which quantity of seed would give the best results

in the production of grain and straw. The experiment has therefore been conducted for six years in succession. The following table gives the quantities of oats and barley sown together, and the average yield of grain per acre in the average of six years' experiments :

Oats.	Barley.	Yield per acre.
		Pounds.
$\frac{1}{2}$ bushel	$\frac{1}{2}$ bushel	2,240
$\frac{1}{2}$ bushel	1 bushel	2,163
$\frac{1}{2}$ bushel	$1\frac{1}{2}$ bushel	2,214
1 bushel	$\frac{1}{2}$ bushel	2,266
1 bushel	1 bushel	2,290
1 bushel	$1\frac{1}{2}$ bushel	2,281
$1\frac{1}{2}$ bushel	$\frac{1}{2}$ bushel	2,216
$1\frac{1}{2}$ bushel	1 bushel	2,241
$1\frac{1}{2}$ bushel	$1\frac{1}{2}$ bushel	2,177

We see by the foregoing figures that the greatest number of pounds of grain per acre was produced from a mixture of one bushel of oats (34 lbs.) and one bushel of barley (48 lbs.) per acre, or by a total amount of 82 pounds of the mixed seed per acre.

A MIXTURE OF OATS AND BARLEY WITH AND WITHOUT SOME OTHER GRAIN FOR SEED PURPOSES. In 1902, in 1903, and again in 1904, an experiment was conducted in duplicate in order to ascertain whether the seed mixture of one bushel of oats and one and a half bushels of barley per acre could be improved by the addition of a small quantity of some other kind of seed. In addition to the standard mixture of oats and barley, one-half bushel of grain was used in each mixture. The following yields per acre show the average results of the two tests for each of the three years as follows :

Standard Mixture	lbs.
" " and 30 lbs. Wild Goose Spring Wheat	2,509
" " " 22 pounds of Emmer	2,480
" " " 28 " Flax	2,500
" " " 30 " Black Hulless Barley	2,511
	2,469

The average results of this experiment for three years seem to indicate that it is very difficult to surpass the standard mixture of barley and oats in yield per acre by adding small quantities of other kinds of seed. If only one bushel of barley had been used instead of one and a half bushels for the standard mixture, possibly the other seed might have exerted an influence slightly more marked than is seen in the results of this experiment. A mixture of oats, barley, and flax has given very good satisfaction.

TWELVE KINDS OF GRAIN GROWN IN COMBINATION. In the spring of 1902, an experiment was started in growing twelve kinds of grain in different combinations. One of the principal objects of this experiment was to ascertain the relative value of different kinds of grain when grown in combination in comparison with the same grains when grown separately. The different grains used for this mixture were as

follows: Mandscheuri barley, Black Hulless barley, Spring rye, Early Alaska oats, field peas, Joannette Black oats, White Hulless barley, Emmer, Grass peas, Wild Goose spring wheat, vetches, and flax. The mixtures were made up in two different ways—first, by using the same amount of seed of each variety which is usually sown when the grains are grown separately, and second, by using equal quantities of seed of all the varieties. Each of the mixtures here described was sown at the rate of 56, 84, 112, 140, and 168 pounds of seed per acre. Each part of the experiment was conducted in duplicate. It will therefore be seen that there were four tests made with these different mixtures in each of the four years, and that sixty plots have been used for the test during the years 1902, 1903, and 1904. The average results for the three years show that 112 pounds of the mixture of seed per acre produced a greater yield of grain than either of the two lighter or the two heavier seedings.

The crop produced by the mixture of twelve kinds of grain and sown at the rate of 112 pounds per acre was carefully analysed in order to ascertain the percentage of yield of each of the separate crops. Those varieties which had the largest average percentage of seed in the crops produced were as follows: Mandscheuri barley, Black Hulless barley, Spring rye, Joannette Black oats, and Early Alaska oats. These five varieties furnished about two-thirds of the entire crop; while the other third was produced by the White Hulless barley, field peas, Grass peas, Emmer, Wild Goose spring wheat, Common Spring vetches, and flax. The Mandscheuri barley had the largest and the flax the smallest percentage in the crop produced from the mixture of the twelve varieties. This experiment goes to confirm other experiments, and to show that it is very difficult to make a mixture which will produce a heavier yield of grain per acre than one made of barley and oats.

VARIETIES OF OATS AND BARLEY FOR GROWING IN COMBINATION. If oats and barley are grown in combination, it is, of course, important to secure those varieties which will mature at about the same time. In order to do this, it is necessary to use a very early variety of oats with an ordinary ripening barley, or a very late variety of barley to use with an oat which matures at an average date. Of all the varieties which we have used in combination, we have found that the Early Daubeney oats and the Mandscheuri barley make a very excellent combination. Another mixture which has given good satisfaction is the Siberian or Banner oats and the Chevalier two-rowed barley. It is, however, difficult to secure true seed of the Chevalier barley in Ontario at the present time. Taking everything into consideration, the first mixture here mentioned is one of the most satisfactory to use at the present time.

MANGELS.

The number of acres used for the mangel crop in Ontario has been greatly increased within the past twelve years. According to the

report of the Bureau of Industries, we learn that from 1882 to 1902 an annual average area of 31,993 acres was used for the growing of mangels. In 1893 there were only 21,519, in 1894. 27,670, and in 1895, 34,383 acres. From that time forward there has been a gradual increase in the acreage of mangels up to 1903, when no less than 80,918 acres were used for this important crop in Ontario. In 1904, however, the acreage dropped to 71,344 acres, owing, no doubt, to the unfavorable weather at that time in the spring when the farmers were ready to sow their mangel crop. The average yield of mangels per acre for Ontario for the past twenty-three years has been 459 bushels, or about 13.8 tons.

VARIETIES. Twenty-three varieties of mangels have been carefully tested in our experimental grounds for five years in succession. The seeding has usually taken place near the first of May. There have been three rows of each variety, each row being four rods in length. Three and a third links (26 2-5 inches) were allowed between the rows, and ten inches between the mangels in the rows. The same distance was allowed between the different varieties as between the rows of the same variety. Level cultivation was practised throughout. The average results for the five years in yield of tops and in yield of roots per acre as follows :

Varieties.	Average results for five years.	
	Yield of tops per acre.	Yield of roots per acre.
	Tons.	Tons.
1. Yellow Leviathan	5.44	34.16
2. Mammoth Golden Giant	5.90	33.79
3. Sutton's Mammoth Long Red	5.82	33.36
4. Oblong Giant Yellow or Giant Yellow Inter	5.26	33.28
5. Steele, Briggs Giant Yellow Inter....	5.66	33.12
6. Carter's Mammoth Prize Long Red	6.15	32.66
7. Evans' Improved Mammoth Sawlog..	6.53	32.40
8. Norbitan Giant	6.02	31.82
9. Simmers' Improved Mammoth Long Red	6.62	31.77
10. Steele's Long Red Selected	6.06	31.13
11. Cornish Giant Yellow Globe	2.30	31.06
12. English Prize	6.52	30.64
13. Giant Yellow Half Long	5.03	30.61
14. Long White	5.79	30.07
15. Buckbee's Mastadon	6.79	30.07
16. Rennie's Perfection Mammoth Long Red	5.85	29.83
17. Carter's Windsor Prize Taker Yellow Globe	2.24	29.60
18. Daniels' Improved Gate Post	3.32	29.39
19. Carter's Elephant Yellow Globe	2.61	28.91
20. Taber's Gate Post Yellow Inter	3.45	28.78
21. Rivershall Giant Yellow Globe	2.57	28.24
22. Red Globe	4.30	27.95
23. Mammoth Red Intermediate	3.39	26.11

The Yellow Leviathan, which stands at the head of the list in yield of roots per acre, is a yellow intermediate variety which has given very

excellent satisfaction. In connection with the co-operative experimental work throughout Ontario in 1904, the Yellow Leviathan also gave the greatest yield of roots per acre, and, of the three varieties distributed, it was the most popular among the experimenters. The seed of this variety was obtained from D. M. Ferry, Windsor, Ontario. Within the past fifteen years, we have grown upwards of twenty-five different strains of the long red mangel, all of which have been surpassed by Yellow Leviathan intermediate variety.

In 1904, thirty-two varieties of mangels were under test. Among the newer kinds, the following produced the greatest yield per acre: Griewener, 29.9 tons; Giant Eckendorf, 28.1 tons; and Rennie's Golden Giant, 24.6 tons.

SOAKING SEED BEFORE PLANTING. For three years, an experiment has been conducted in which mangel seed has been soaked twelve, twenty-four, and thirty-six hours before sowing in comparison with mangel seed which was sown without being soaked. The average results of the three years' tests show that the mangel seed which was soaked twelve hours gave the highest yield of roots per acre, the average being 22.9 tons, as compared with 20.1 tons produced from the unsoaked seed. It is quite probable that the condition of the land at the time of sowing has much to do with the comparative results from soaked and unsoaked seed.

SUGAR BEETS.

The total area devoted to the growing of sugar beets in Ontario is still quite limited. A considerable amount of interest, however, has been taken in this crop during the past few years, both for feeding purposes and for the manufacture of sugar. Usually those varieties which give a large yield per acre, are easily harvested, and contain an average of about ten per cent. of sugar, are the ones used for feeding purposes; and those varieties which grow mostly underground and furnish about 15 per cent. of sugar are the ones sown for sugar production.

VARIETIES. In our experimental work, we have made a comparative test of thirty-two varieties of sugar beets within the past five years. These include some of the leading varieties as grown for feeding purposes, and also some of the leading kinds which have been specially bred in Germany for many years for the production of sugar. In 1900 and in 1901, the sugar beet seed was planted in rows 26 inches apart, and the plants were thinned to a distance of 7.9 inches apart in the rows. In 1902, 1903, and again in 1904, however, all the varieties were planted in rows 21 inches apart, and a distance of seven inches was left between the plants. The thinning took place when the plants were quite small. Level cultivation was practised throughout. The following table gives the average yield per acre of duplicate experiments conducted with nineteen varieties in 1900, twenty-one

varieties in 1901, thirty varieties in 1902, and thirty-two varieties in 1903 and again in 1904, as well as the average for the number of years that each variety was grown.

Varieties.	Yield of roots per acre.					Average Tons.
	1900. Tons.	1901. Tons.	1902. Tons.	1903. Tons.	1904. Tons.	
1. Giant White Feeding	14.05	17.22	25.38	31.53	38.44	25.32
2. Royal Giant.....	14.95	19.29	29.63	26.55	33.14	24.71
3. New Danish Improved	19.10	18.60	27.88	27.44	29.08	24.42
4. Red Top.....	24.25	19.63	26.81	20.83	30.38	24.38
5. Giant Rose Feeding	14.50	17.67	25.38	31.11	32.84	24.30
6. Red Skinned	21.55	20.60	22.38	22.36	28.39	23.06
7. White French.....	17.35	14.39	29.06	26.08	26.63	22.70
8. Green Top White	18.35	18.91	26.56	20.47	25.73	22.00
9. White Silesian.....	21.45	18.15	25.94	21.23	22.28	21.81
10. Lane's Improved	20.45	16.28	22.75	22.08	24.30	21.17
11. Carter's Nursery	13.35	14.93	29.38	27.02	20.78	21.09
12. Queen of the Danes	11.65	12.63	20.00	29.27	25.91	21.09
13. Jersey	13.70	14.63	20.69	23.06	30.31	20.48
14. Champion.....	19.25	17.18	22.38	21.00	20.28	20.02
15. Kleinwanzlebener.....	14.38	16.81	23.06	20.97	24.89	20.02
16. Pitzscheke's Elite	14.85	14.61	20.63	30.70	21.20	18.40
17. Imperial Grey Top	11.85	15.87	21.81	22.39	19.59	18.30
18. French Yellow	13.15	15.14	23.19	19.48	19.25	18.04
19. Improved Imperial	14.00	14.22	21.32	19.88	16.66	17.20
20. Mangel Sugar Beet		13.01	20.50	21.27	19.05	18.47
21. Vilmorin's French Sugar		13.22	19.44	21.45	16.38	17.62
22. Ideal			30.13	31.69	32.16	31.32
23. Tankard Cream			28.56	28.75	34.31	30.54
24. Rennie's Giant Sugar			33.00	26.50	29.14	29.55
25. Rubensamen (Rimpau)			21.06	19.67	21.02	20.58
26. Kleinwanzlebener (Mette)			21.50	22.44	17.22	20.39
27. Jaensch's Vicitrix			21.44	21.23	17.83	20.17
28. Dieckman No. 3.....			20.44	19.86	19.52	19.94
29. Dieckman No. 1.....			19.63	19.33	19.94	19.63
30. Dieckman No. 2.....			19.13	18.52	18.58	18.74
31. Hybrid Sugar Beet Mangel				25.23	24.22	24.73
32. Imperial Giant Half Sugar				25.02	21.06	23.04

In the average results for five years, the Giant White Feeding variety now occupies the highest place in yield of sugar beets per acre. The yield of this variety in 1904 was very large, being 38.4 tons per acre. The Royal Giant variety, which stood third in average yield of roots per acre in the average results for the last year, now occupies second place. The Kleinwanzlebener variety, which is so extensively used in the United States and Canada for sugar production, has given an average of 20 tons per acre for five years. This is considerably larger than is usually obtained in general practice, 15 tons being considered a satisfactory crop in general field cultivation. Among the newer varieties, the Ideal stands very high, giving an average of 31.3 tons per acre for three years. This is a special variety which has been bred up by Mr. A. Kirsche, of Germany, for stock feeding purposes. Several of the varieties near the end of the list, which have been grown for three years, were obtained from different sugar beet breeders in Germany who have made a specialty of selecting beets for years in order to obtain a high percentage of sugar. For the results of the

chemical analyses of these beets, the reader is referred to the report of the Chemical Department, written by Prof. Harcourt, in the Report portion of this bulletin.

Some of the varieties of sugar beets have been grown at the College in uniform tests for eleven years in succession, the average results of the tests for the eleven years give us the following yields per acre for the different varieties: Red Top, 20.7 tons; Lane's Improved, 20 tons; White Silesian, 19.7 tons; White French, 19.1 tons; Champion, 18.9 tons; Red Skinned, 18 tons; Kleinwanzlebener, 17.5 tons; and Improved Imperial, 15 tons. In the average results for nine years, three other varieties have given the following average yields per acre: New Danish Improved, 22.6 tons; Jersey, 20.3 tons; and French Yellow, 18.1 tons.

PLANTING SUGAR BEETS AT DIFFERENT DISTANCES BETWEEN THE DRILLS. For three years in succession, an interesting experiment has been conducted in planting sugar beets at different distances in the rows. A comparison of nine different distances between the rows was made. Seven rows were sown at each distance apart. At the time of harvest, however, the two outside rows of each plot were discarded, and only the five inner rows were used in determining the comparative yields. The plants were thinned when very young, and were allowed to remain seven inches apart in the rows. Flat cultivation was used throughout. The experiment was conducted in duplicate, the Kleinwanzlebener variety being used in each of the tests. The average results of three years' tests in average weight per root, yield of tops per acre, and yield of roots per acre, are here presented:

No.	Distances.	Average of six tests.		
		Average weight per root, 1902-3-4.	Yield of tops per acre, 1902-3-4.	Yield of roots per acre, 1902-3-4.
		Lbs.	Tons.	Tons.
1	Rows 12 inches apart.....	.71	11.37	23.02
2	" 14 ".....	.74	8.92	21.43
3	" 16 ".....	.80	9.22	20.66
4	" 18 ".....	.87	9.39	20.25
5	" 20 ".....	.96	9.28	20.23
6	" 22 ".....	1.01	9.47	19.74
7	" 24 ".....	1.07	8.96	19.38
8	" 26 ".....	1.14	8.92	19.09
9	" 28 ".....	1.20	8.69	17.83

It will be observed that the average results show regularity throughout. As the distance between the rows increased, there was a gradual increase in the comparative size of the individual roots, but a decrease in the yield of roots per acre. The roots which were placed in rows 18 inches apart, which is usually the distance recommended for the growing of beets for sugar production, produced an average of 20½ tons of roots per acre. Some people think that larger yields can be obtained by having the rows of sugar beets 28 to 30 inches apart.

The average results of the six tests conducted within the past three years, however, have given us about 2 1-2 tons per acre more from the sugar beets grown in rows 18 inches apart as compared with those grown in rows 28 inches apart. Samples from the various parts of this experiment were taken to the chemical laboratory and were analyzed by Prof. Harcourt, in order to ascertain the percentage of sugar from beets grown in rows at different distances apart. For the results of these analyses, the reader is referred to the report of the Chemical department, to be found in the Report of the College for 1904.

THINNING SUGAR BEETS AT DIFFERENT DISTANCES IN THE DRILLS. For two years in succession, an experiment has been conducted with sugar beets by thinning the plants to two, four, six, eight, and ten inches apart in the rows. Each plot consisted of six rows, fifty links (2 rods) in length, and eighteen inches apart. The experiment was conducted in duplicate in each of the two years, the Kleinwanzlebener variety being used throughout. The average results of the four tests made in the two years are as follows:

Distance Between Plants.	Average weight per root.	Average yield of roots per acre.
	Pounds.	Tons.
2 inches	.52	19.7
4 inches	.87	16.7
6 inches	1.02	16.2
8 inches	1.21	15.1
10 inches	1.47	14.9

The results of this experiment seem to indicate that as the distance between the sugar beets in the rows increases, the average size of the individual roots also increases, but the yield of roots per acre decreases.

FLAT AND RIDGED CULTIVATION. Sugar beets have been grown on the flat and on ridges in an experimental way in each of three years. The experiment in each year was conducted in duplicate. Each plot consisted of six rows, each row being fifty links (2 rods) in length. The Kleinwanzlebener variety was used throughout. The average results for the six tests conducted in the three years gave 18.82 tons per acre from the flat cultivation, and 18.17 tons per acre from the ridged cultivation. These results, therefore, show that for the three past years, about two-thirds of a ton more of sugar beets per acre have been obtained from the flat as compared with the ridged cultivation.

THINNING PLANTS AT DIFFERENT STAGES. In each of the years 1903 and 1904, sugar beet plants were thinned when they were one-half inch, two inches, five inches, and eight inches in height. The experiment was conducted in duplicate each year, and the Kleinwanzlebener variety of sugar beets was used. The highest average yield per acre

of the four tests conducted in the two years was obtained from the thinning which took place when the plants were two inches in height, the yield being fully one ton per acre more than for any of the other thinnings.

SOAKING SUGAR BEET SEED BEFORE PLANTING. An experiment has been conducted for two years in succession by soaking sugar beet seed for twelve, twenty-four and thirty-six hours, and then sowing this seed as well as unsoaked seed in order to ascertain the comparative results of the different treatments. The experiment was conducted in duplicate each year. In each of the two years, the unsoaked seed gave the lowest yield of roots per acre. The results show us the greatest yield of roots per acre was obtained from the seed which was soaked for twelve hours in 1903, and from that which was soaked for twenty-four hours in 1904.

FIELD CARROTS.

In 1904, twenty-five varieties, and for each of the past five years, twenty varieties of field carrots have been grown in our experimental grounds. The carrot seed was sown on the level with a root drill in rows three and one-third links (26 2-5 inches) apart, and, when the plants were still quite small, they were thinned to an average distance of four inches apart in the rows. Three rows, each four rods in length, were used for each variety, thus making the plots exactly one one-hundredth of an acre in size. The average results for five years in weight per root, yield of tops per acre, and yield of roots per acre, are as follows:

Varieties.	Average results for five years.		
	Weight per root.	Yield of tops per acre.	Yield of roots per acre.
	Lbs.	Tons.	Tons.
1. Mastadon White Intermediate.....	1.04	6.68	31.16
2. Mammoth Intermediate Smooth White	1.06	6.81	31.10
3. Steele's Improved Short White.....	1.01	6.76	30.08
4. Iverson's Champion White Intermediate	1.00	6.25	29.98
5. Sutton's Matchless White.....	.98	7.69	29.44
6. Carter's Hundred Ton	.96	6.06	29.17
7. Simmer's Short White Vosges	.96	6.56	28.03
8. Large White Belgian.....	.93	6.55	27.75
9. Long Yellow Stump Rooted	.87	5.32	26.57
10. Large White Vosges	.90	5.95	26.50
11. Pearce's Improved Half Long White.....	.87	7.72	25.90
12. Daniel's Giant Yellow Intermediate.....	.83	6.60	25.05
13. Sutton's Yellow Intermediate	.84	6.61	25.02
14. Carter's Gate Post Orange Long	.82	6.96	24.95
15. Rubicon Half Long Red	.83	5.45	24.83
16. Victoria Long Red	.81	6.58	24.04
17. Guerande	.78	4.86	23.55
18. Chantenay Short Red	.78	5.21	23.48
19. Danver's Orange.....	.79	5.90	21.73
20. Half Long Stump Rooted	.63	3.42	18.65

There are several varieties of intermediate white carrots, which are represented by different names and are obtained from different sources, which are quite similar in character of growth and in appear-

ance, and which present results having variations that are not extreme. For instance, we observe from the table here presented that the Mastadon White Intermediate, the Mammoth Intermediate Smooth White, the Steele's Improved Short White, the Iverson's Champion White Intermediate, the Sutton's Matchless White, and the Carter's Hundred Ton, which are all intermediate white varieties, have a variation of about two tons per acre in the average results for five years. In comparison with this, however, we notice that the Half Long Stump Rooted gave a yield of only 18.7 tons of roots per acre.

Of the newer varieties, not included in the table here presented, the White Griewener, the American Beauty, the Carter's Orange Giant, and the Sutton's Magnum Bonum are among the most promising varieties.

SWEDE TURNIPS.

Although the acreage sown to Swede turnips in Ontario at the present time is not much greater than the average for the past twenty-three years, we notice that there is yet nearly one-half as much more land devoted to the growing of this crop than to the cultivation of mangels and carrots combined. According to the report of the Bureau of Industries for Ontario, the average yield of turnips per acre for the past twenty-three years is 434 bushels, or about 13 tons per acre. The average yield of turnips throughout Ontario is 25 bushels, or three-quarters of a ton per acre less than that of mangels.

VARIETIES. Upwards of eighty varieties of Swede turnips have been under experiment at the College within the past fifteen years. Those varieties which produced the poorest results have been dropped from the list from time to time and only the leading varieties continued in the experiments. The following gives the names of leading varieties, with their average yield of roots per acre for the past five years: Sutton's Magnum Bonum, 23 tons; Buckbee's Giant, 21.9 tons; Kangaroo, 21.5 tons; Hall's Westbury, 20.9 tons; and Hartley's Bronze Top, 20.7 tons. In the co-operative experiments throughout Ontario, the Sutton's Magnum Bonum has given the highest yield of roots per acre in each of the years 1902, 1903, and 1904.

SELECTION OF SEED. For five years in succession, experiments have been conducted with the object of securing information regarding the comparative value of different selections of turnip seed. Each year some of the best commercial seed of a leading variety of Swede turnips was purchased for this experiment. With the aid of sieves, the seed was carefully graded into large, medium, and small. The seed of each selection was then carefully hand-picked in order that nothing but apparently sound and perfect seed was used. The experiment was conducted in duplicate each year. The average results for the five years show the following yields of roots per acre: Large seed, 17.1 tons; medium-sized seed, 15.2 tons; and small seed, 8.7 tons.

FALL TURNIPS.

Although fall turnips, soft turnips, or, as they are sometimes called, yellow and white flesh turnips, yield heavily per acre, they are not grown very extensively throughout Ontario, owing, no doubt, to the fact that they do not keep very late into the winter, but are more specially suited for feeding in the autumn of the year.

VARIETIES. Sixteen varieties were under test in 1904, and the results show that the highest yields per acre were produced by the Red Top White Globe, 44 tons; White Egg, 38 tons; Early American Red Top, 37 tons; Sutton's Imperial Green Globe, 37 tons; Sutton's Purple Top Mammoth, 37 tons; Carter's Commonwealth, 35 tons; and Carter's Purple King, 35 tons.

In some seasons, this class of turnips is considerably damaged by what is commonly called the "turnip rot." This disease attacks the turnips during the growing season, and sometimes causes the root to become either partially or wholly decayed before they have been harvested. We have counted the number of sound roots, and also the number of decayed roots of each of the varieties grown in our experimental grounds for several years in succession. The crops grown in 1899, 1900, 1902, and 1903 were almost free from rot; while those grown in 1897 had 51 per cent; in 1898, 30 per cent; in 1901, 15 per cent; and in 1904, 2 per cent of rot. We submit herewith a table giving the names of the varieties and the percentage of the crop which was diseased in each of the years 1897, 1898, and 1901, with the average percentage of diseased roots for the three years.

Varieties.	Per cent. of crop diseased.			
	1897.	1898.	1901.	Average 3 years.
1. Cow Horn	2	7	5	5
2. Early American Purple Top	8	6	1	5
3. Yellow Stone	8	5	12	8
4. White Egg ..	16	13	1	10
5. Jersey Navet	28	2	..	10
6. Red Top Strap Leaf	29	7	5	14
7. Yellow Montgomery	14	31	2	16
8. Jersey Lily	27	4	20	17
9. Purple Top Mammoth	23	26	5	18
10. Milk Globe	26	27	7	20
11. Greystone Improved	46	14	3	21
12. White Lily	50	16	2	23
13. Green barrel	37	24	10	24
14. White Six-weeks	32	32	8	24
15. Red Top White Globe ..	19	58	4	27
16. White Stone	62	6	13	27
17. Sutton's Imperial Green Globe	39	34	9	27
18. Early White Model	35	21	27	28
19. Large White Norfolk	42	35	7	28
20. Early La Crosse	84	4	3	30
21. Purple Top Hybrid	59	12	26	32
22. Red Globe Norfolk	81	9	16	35
23. Jarman's Selected Green Globe	47	53	11	37

Varieties.	Per cent. of crop diseased.			
	1897.	1898.	1901.	Average 3 years.
24. Yellow Finland	71	35	7	38
25. Long Tankard	66	43	6	38
26. White Flat Dutch Strap Leaf	54	59	3	39
27. Imperial Green Globe	43	27	48	39
28. Orange Sweet	77	36	11	41
29. Early Purple Top Munich	63	42	21	42
30. Sutton's Purple Top Scotch	78	42	7	42
31. Pomeranian White Globe	88	22	20	43
32. Orange Jelly	80	9	48	46
33. Sutton's Perfection Green Top	57	78	5	47
34. Sutton's Favorite Purple Top Yellow Hybrid	65	61	15	47
35. Rennie's Selected White Globe	79	65	4	49
36. Yellow Aberdeen Green Top	77	21	52	50
37. Yellow Aberdeen Purple Top	83	19	64	55
38. All Gold	69	55	43	56
39. Extra Early Milan	75	70	23	56
40. Yellow Globe	83	65	31	60
Average	51	30	15	32

Evidently the information given by Prof. F. C. Harrison on pages 27 and 28 of the College Bulletin 137, under the heading of "Susceptibility of Varieties," and on pages 16 and 17 of bulletin 136, under the headings of "Susceptibility of Varieties," and "The Planting of Immune Varieties," was based entirely on the notes taken by the Experimental Department in 1901. In bulletin 137, page 28, "Jersey Navet" should read "Jersey Navet"; "Warly La Crosse" should read "Early La Crosse"; "Lutton's Imperial Green Globe" should read "Sutton's Imperial Green Globe"; "Early Purple Top Murrich" should read "Early Purple Top Munich"; and in bulletin No. 136, page 17, "Red Top" should read "Red Top White Globe."

From the results here presented in tabulated form, it will be seen that none of the varieties were immune from the rot in the average of the three years' tests, but that three varieties, viz., the Cow Horn, the Early American Purple Top, and the Yellow Stone, had less than 10 per cent. of diseased roots. Those varieties having 10 and under 20 per cent. of decayed turnips were the White Egg, Jersey Navet, Red Top Strap Leaf, Yellow Montgomery, Jersey Lily, and Purple Top Mammoth.

In averaging the results for the five years during which the fall turnips were practically free from rot, we find the yield of each of five varieties to be as follows:

Varieties.	Yield of tops per acre.	Average weight per root.	Yield of roots per acre.
	tons.	lbs.	tons.
Red Top White Globe	4.2	2.23	26.5
White Egg	5.2	2.00	23.0
Early American Purple Top	4.8	1.84	21.0
Cow Horn	6.2	1.79	18.6
Jersey Navet	6.9	1.64	16.9

From these results, we learn that the Early American Purple Top and the White Egg varieties are not only among the freest from rot, but they are also heavy yielding varieties. The Jersey Navet turnip, which formerly gave very good yields, has given unsatisfactory returns during the past few seasons; so much so that we have dropped it from our lists entirely in our experiments with fall turnips in 1904.

SELECTION OF SEED. Large, medium, and small sized turnip seed has been sown on separate plots in each of four years. The experiment was conducted in duplicate each year, so that we now have average results of eight separate tests. The seed used on the different plots was of the same variety and of practically the same quality, except in size. The average yields produced from the different selections for the four years are as follows: Large seed, 25.4 tons; medium-sized seed, 21.7 tons; and small seed, 16.2 tons per acre.

PARSNIPS.

Parsnips have not been grown very generally as a farm crop in Ontario. Enquiries have been received occasionally, however, asking about the yields of parsnips as compared with other classes of roots for cultivation as a stock food. Four varieties have now been grown for five years, the average yield of roots per acre being as follows: Buck-bee's New Sugar, 11.5 tons; New Ideal Hollow Crown, 11 tons; Improved Half Long, 10.3 tons; and Improved Long Smooth, 10.1 tons. The Sutton's Cattle variety, which has been grown for four years in succession has given an average of 10.2 tons of roots per acre. It will be observed that the parsnips have yielded considerably less per acre than the leading varieties of mangels, sugar beets, turnips, or carrots.

KOHL RABI.

This crop is sometimes grown for food for stock in some of the older countries. The root of the kohlrabi is somewhat like that of cabbage; while the leaves resemble those of Swede turnips. The valuable part of the plant, however, grows about three inches above the level of the ground in the form of a bulb. Kohlrabi makes a very nice food for domestic use, and is prepared for culinary purposes in much the same way as Swede turnips. The seed of kohlrabi resembles very closely that of Swede and fall turnips, and the crop is grown in much the same manner as turnips.

The following is the average yield in tons per acre of each of two varieties of kohlrabi grown in the experimental grounds for six years: Early White Vienna, 20.7 tons and Earliest Erfurt, 18.2 tons. The Goliath Purple variety, which has been grown for three years, gave an average of 16.7 tons per acre. In the crop of 1904, the yields were very high, being as follows: Early White Vienna, 27 1-2 tons; Earliest Erfurt, 26.9 tons; and Goliath Purple, 18.3 tons per acre. It will be seen from these results that the Early White Vienna gave the largest yield per acre in 1904, and also in the average of six years.

POTATOES.

According to the reports of the Bureau of Industries, the potatoes grown in Ontario within the past twenty years have given a greater market value per acre than any other farm crop grown throughout the Province, being slightly in advance of that of field carrots, turnips, or mangels, and about three times as great as wheat, oats, barley, or peas.

VARIETIES. One hundred and four varieties of potatoes were grown in the Experimental department in 1904, on what might be termed an average clay loam. Three rows each four rods in length and three and a third (26 2-5 inches) apart were used for each variety. Owing to the unfavorable weather during the latter part of May and the early part of June, the potatoes were not planted in 1904 until the tenth day of June. Furrows were made with a double mould board plow, and fifteen pounds of each variety were planted and covered to a depth of about four inches. Level cultivation was used throughout the season. Blue Death, which is claimed to be an insecticide and also a fungicide, was sprayed on the tops of all the varieties on July 13th, July 25th, and August 3rd. When the potatoes were dug in the autumn, careful determinations were made regarding the exact percentage of rotten potatoes, the yield of sound potatoes per acre, and the percentage of potatoes which were of the proper size to be marketable. As the rot both at the College and throughout Ontario was very bad in 1904 as well as in 1903, it is thought wise to present the results of all the varieties which were under experiment during both of these years. A table is therefore presented, giving the average number of days to reach maturity, the yield of sound potatoes per acre, and the percentage of rotten potatoes of each of the eighty-two varieties grown in 1903 and 1904.

Varieties.	Average results for two years, 1903-04.		
	Number of days in reaching maturity.	Yield of sound potatoes per acre.	Percentage of potatoes rotten.
		Bus.	
1. Holborn's Abundance	111	294.2	3.4
2. Robertson's Champion	110	221.0	3.7
3. Skerries	111	119.8	3.7
4. Up-to-date	110	242.8	3.8
5. Stray Beauty	87	195.5	4.8
6. Sensation	109	187.2	5.1
7. Tremendous	108	171.3	5.3
8. Factor	110	206.1	5.3
9. Early Pinkeye	84	259.0	5.4
10. Green Bay	84	200.4	6.5
11. Seedling No. 230	93	290.1	7.0
12. Main Crop	112	241.0	8.3
13. Bliss Triumph	92	243.8	9.5
14. Gemmell's Seedling	106	117.7	11.3
15. Salzer's Earliest	90	279.8	12.1
16. Irish Cups	103	267.5	13.9
17. Always	97	204.2	14.6
18. Howe's Premium	102	255.2	20.1
19. Carman No. 2	100	172.3	21.4

Varieties.	Average results for two years, 1903-04.		
	Number of days in reaching maturity.	Yield of sound potatoes per acre.	Percentage of potatoes rotten.
		Bus.	
20. Dewey	101	200.4	21.9
21. Carter's Royalty	101	106.7	23.4
22. White Giant	98	134.4	25.0
23. Early Short Top	93	106.0	26.1
24. Lightning Express	91	200.4	26.5
25. Burbank's Seedling	102	195.0	28.0
26. Sir Walter Raleigh	99	165.6	28.2
27. Empire State	105	232.5	28.9
28. Jersey Snowdrop	98	147.1	29.1
29. Snowflake	94	161.1	31.3
30. Early Michigan	90	164.0	31.6
31. Rural Blush	105	196.5	32.7
32. Carman No. 1	109	170.4	33.3
33. American Wonder	103	218.1	34.4
34. Dempsey's Seedling	102	218.5	34.9
35. Rural New Yorker No. 2	103	178.5	35.1
36. Uncle Sam	101	148.1	35.5
37. North Pole	95	156.7	35.6
38. Pearl of Savoy	103	223.8	35.7
39. Celtic Beauty	101	144.6	35.8
40. King of Michigan	97	157.1	35.8
41. Steele's Earliest of All	96	192.4	36.0
42. Canadian Beauty	91	158.5	36.7
43. Early Dawn	89	174.0	36.8
44. New White Beauty	102	135.6	36.9
45. Adirondac	107	165.6	37.4
46. Bovee	93	163.1	37.6
47. Early Ohio	89	158.1	38.1
47. Todd's White Monarch	106	174.0	38.4
49. Sunlit Star	102	165.0	39.3
50. Early Thoroughbred	99	155.6	39.5
51. Early Rose	102	138.8	39.9
52. Six Weeks	90	145.6	40.3
53. Woodhull	102	194.6	40.3
53. Early Fortune	89	153.1	41.2
55. Early Andes	89	165.4	41.6
56. Early Market	93	156.7	41.7
57. Crown Jewel	102	196.9	41.9
58. Burpee's Extra Early	99	137.5	42.1
59. White Elephant	102	198.9	42.8
60. Dublin Prize	99	126.3	43.8
61. Rose of Quebec	102	150.4	44.3
62. Dobson's Early	96	102.9	44.5
63. Rose's New Invincible	102	161.0	44.5
64. Democrat	101	145.8	44.9
65. Burnaby Mammoth	102	163.6	45.5
66. The Daisy	100	167.1	46.0
67. Gem of the Hebrons	102	164.4	47.5
68. Acme	91	123.8	48.2
69. Leamington	102	141.9	48.6
70. Rose of the North	98	159.4	48.6
71. Wonder of the World	98	136.3	49.9
72. Brown's Prolific	102	145.2	50.3
73. Morning Star	105	147.1	50.3
74. New Queen	102	130.6	50.4
75. Lady Finger	99	106.9	50.9
76. Surprise	102	134.4	51.1
77. Hanlan Beauty	102	129.6	52.8
78. Early Dominion	95	122.7	53.3
79. White Pinkeye	102	104.8	54.2
80. Beauty of Hebron	102	153.3	56.2
81. Weld's Orange	99	103.3	56.9
82. Montana Bluff	105	144.2	58.3
Average	100	171.8	33.0

As the varieties presented in the table are arranged in the order of the percentage of rotten tubers, starting with the smallest and finishing with the greatest percentage of rot, the results regarding the percentage of disease are shown quite clearly. It will be seen that the Holborn Abundance, Robertson's Champion, Skerries, Up-to-date, and Stray Beauty varieties each had less than five per cent. of rot in comparison with the Beauty of Hebron, Weld's Orange, and Montana Bluff, each of which had upwards of fifty-five per cent. of rot.

It is claimed by some that early potatoes, and by others that late potatoes, are the freest from the attacks of this disease. According to the reports of the last two years, the average results of ten early, ten medium, and ten late varieties of potatoes are as follows:

Classes According to Maturity.	Number of days in reaching maturity.	Percentage of rotten potatoes.
Ten early varieties	88	25.8
Ten medium varieties	100	33.8
Ten late varieties	110	10.9

From these results, it appears that of all the varieties grown in the Experimental Department in each of the past two years, the late varieties, as a whole, were the freest from rot.

Those varieties which had the largest percentage of rot did not yield as many sound potatoes as the varieties having the least percentage of rot, as will be seen by the following figures:

Amount of Rot.	Bushels of sound potatoes per acre.	Percentage of rotten potatoes.
Twelve varieties having the least rot....	219.2	5.2
Twelve varieties having the most rot	129.9	52.9

This gives us some idea of the great loss caused by means of the rot on the potato crop of the past two years. The November Crop Bulletin for 1904 had the following regarding the condition of the potato crop: "The extent of the loss from rot is variously estimated at from twenty to fifty per cent." This will show the importance of planting those varieties which produce large yields of potatoes of good quality and which are less subject to rot than other varieties.

In averaging the yields per acre produced by each of forty-six varieties of potatoes grown in the experimental grounds for the past five years in succession, the greatest number of bushels of sound potatoes were produced by the following: Empire State, 269; Seedling No. 230, 256; Dempsey's Seedling, 252; Pearl of Savoy, 251; White Elephant, 251; American Wonder, 247; Holborn Abundance, 247; The Daisy, 243; Rural New Yorker No. 2, 243; and Rural Blush, 240.

About twenty new varieties of potatoes were grown in the experimental plots in 1904 for the first time; some of them being grown in very limited quantities, as only a small amount of seed could be obtained. A few potatoes of each of a number of new varieties were sent out by Mr. Kyle, Ontario Special Farm Labor Agent, from the Old Country, and were transferred to the Experimental Department by Prof. C. C. James, Deputy Minister of Agriculture. The varieties were as follows: Davies' Foundling, Davies' King Loth, Davies' Warrior, Davies' Dunion, and Scottish Triumph. As these varieties were planted in such small quantities, no record can here be made regarding the yield per acre for 1904. Of the Davies' Warrior there were in all twenty hills, and no rotten potatoes were found in the crop. The Davies' Dunion had only thirteen hills, and there was only one rotten potato at the time that the crop was harvested. It is unsafe, however, to say, from these results, that the Davies' Warrior is immune from this disease, as similar areas of land on which a few of other varieties were grown also gave no rot in 1904, but when a larger area was taken into consideration a few rotten potatoes were found.

In order to obtain fuller information regarding the comparative yield of very early potatoes, six rows of each of nine varieties have been planted in the spring of each of the years 1902, 1903, and 1904. Two rows of each variety were dug at the end of nine weeks, two rows at the end of twelve weeks, and the two remaining rows at the end of fifteen weeks after the planting took place. In the average for three years, the greatest yields produced at nine weeks after planting were by the following varieties: Early Andes, Early Dominion, Six Weeks, Early Fortune, and Early Dawn. The Stray Beauty variety, which gave excellent results in a similar experiment conducted for several years previous to 1902, has produced low yields per acre during the last two or three years. This is true not only in the experiments at the College, but also in the co-operative experiments throughout Ontario. Evidently this variety has passed its best period of life and is now deteriorating.

BORDEAUX MIXTURE FOR THE POTATO BLIGHT. Until the last two years, the potatoes grown in the Experimental Department have been comparatively free from blight, although in some parts of the Province the rot has proven very troublesome in some seasons. In those sections where the blight has been serious, some farmers have had excellent results from the use of the Bordeaux mixture, along with Paris green, the first spraying being done when the plants were about six inches in height, and the second and third sprayings at intervals of ten to fifteen days. In some cases, five or six sprayings of Bordeaux mixture have been made in the same season. In 1903, and again in 1904, an experiment was conducted in our experimental plots by spraying two varieties of potatoes with Paris green and Bordeaux mixture; and also

the same varieties of potatoes with Paris green alone. The potatoes for this experiment were planted in 1903 on June 10th, and the sprayings took place on July 11th, July 23rd, and August 6th; and those in 1904 were planted on June 11th, and the sprayings took place on July 16th, July 29th, and August 4th. The Bordeaux mixture was made in the same way and in the same proportions as described in the College Bulletin No. 122, copies of which may be obtained from the Department of Agriculture, Toronto, Ontario. The results show that there was less rot on the potatoes on which the Bordeaux mixture and the Paris green were used than on those on which the Paris green was applied alone. In the case of both varieties of potatoes on which the Bordeaux mixture was used, the tops kept greener to a later date than those which did not receive this treatment.

DIFFERENT METHODS OF TREATMENT FOR THE POTATO BEETLE.

Owing to the severe ravages of the Potato Beetle in Ontario, an experiment has been conducted in duplicate in each of nine years by using different methods for destroying the insect. The experiment consisted in spraying the potatoes with Paris green and water, Paris green and plaster, and Potato Bug Finish. The test was conducted in duplicate each year. As a rule, three applications were made on each crop. For the sake of comparison, one plot was allowed to remain untreated.

In 1902, in 1903, and again in 1904, six lots of each of two varieties of potatoes were carefully selected and planted on separate plots. After the potatoes had made sufficient growth and the potato beetles (bugs) had made their appearance, five plots of each variety were treated in different ways to destroy the beetle, and one plot of each variety was left untreated as a basis of comparison. The five treatments made in each of the years were as follows: (1) Paris green and water, using one pound of Paris green and 96 gallons of water per acre; (2) Paris green and plaster, using one pound of Paris green and thirty-eight pounds of plaster per acre and applying the mixture to the potatoes in the dry condition; (3) Potato Bug Finish, which was applied dry at the rate of twenty pounds per acre; (4) Bug Death and water, using on an average thirty-two pounds of Bug Death and 96 gallons of water per acre; and (5) Bug Death used in the same proportion as No. 1, but in the dry condition. Three applications of each of the five treatments were made in both cases. In the autumn, the potatoes from each of the twelve plots were dug and weighed. The following are the average results of the smaller experiment conducted for nine years, and of the larger experiment conducted for three years:

Treatments.	Average number of bushels of potatoes per acre.	
	9 years.	3 years.
Nothing	81.8	93.6
Potato Bug Finish	123.2	128.0
Paris green and plaster	132.3	146.9
Paris green and water	140.4	151.5
Bug Death (dry) .....	.....	175.3
Bug Death and water .....	.....	175.5

In seven out of the nine years, those potatoes which were sprayed with Paris green and water surpassed those which were sprayed with Paris green and plaster, in yield of crop per acre. It is also quite noticeable that in each of the nine years the untreated potatoes gave decidedly the lowest yield of tubers per acre. The Bug Death, which has only been tested in our trial grounds for the past three years, is manufactured at St. Stephen, N.B., and has been used to a limited extent throughout Ontario during the last two or three years. The potato tops on which Bug Death was applied were more vigorous in growth and greener in appearance throughout each of the seasons than those on which the other applications were made. In this respect, the Bug Death exerted an influence about equal to a combination of Paris green and Bordeaux mixture in each of the past two years. The usual prices of these insecticides, when bought in quantity, are about as follows: Paris green, 20 cents; Bug Death, 7 cents; and Potato Bug Finish, 1 2-3 cents per pound. The cost, therefore, for the material used in the experiments conducted in 1902, 1903, and 1904, was about as follows: Paris green and water, 60 cents; Paris green and plaster, 88 1-2 cents; Bug Death, \$6.72; and Potato Bug Finish, \$1.00 per acre.

TREATMENT OF POTATOES TO DESTROY THE SCAB. An experiment was again conducted in 1904 by immersing scabby potatoes in a solution of corrosive sublimate for one and a half hours, after which they were spread out to dry; they were then cut and planted in the usual way. The treatment was made with each of two varieties. Both the treated and untreated potatoes were planted at the same time and in the usual manner. The corrosive sublimate solution was made by dissolving corrosive sublimate in hot water in the proportion of $2\frac{1}{4}$ ozs. of the former and two gallons of the latter. The solution was allowed to stand twelve hours, after which it was diluted with 13 gallons of water. As the corrosive sublimate is very poisonous, the material itself should be looked after very carefully and no potatoes which have been treated should be left unplanted. As none of the potatoes had more than one-half of one per cent. of scab in the crop of 1904, the results of this experiment do not furnish much information for this season. Taking the average of four years' results, the potatoes which were treated with corrosive sublimate gave about 7 bushels per acre more than those on which the corrosive sublimate was not used. This treatment has been used with good satisfaction in some places where there is usually a considerable amount of scabby potatoes.

PLANTING DIFFERENT SIZED PIECES AT DIFFERENT DISTANCES APART IN THE ROWS. For three years in succession, an experiment has been conducted by planting one, one and a half, and two ounce pieces of potatoes. The potatoes of each of these sizes were planted twelve, eighteen, and twenty-four inches apart in the row. The average results show that the yield per acre increased in the order of the increase

of the size of the pieces and of the decrease in the distance between the pieces in the row; thus, the highest average yield (177.6 bus.) was produced by the two ounce pieces planted one foot apart in the row, and the lowest yield per acre (107.3 bus.) was produced by the one ounce pieces planted two feet apart in the row.

SELECTION OF SEED. For ten years in succession, large, medium-sized, small, and very small potatoes have been selected continuously and planted from season to season. The crop of 1904 shows, that as the seed decreased in size not only was there a decrease in the yield of potatoes per acre, but there was an increase in the percentage of small tubers.

PLANTING ONE, TWO, AND FOUR POTATO SETS PER HILL. For five years in succession, an experiment has been conducted by planting one, two, and four pieces of potatoes per hill, using the same amount of seed throughout. The average results for the five years are as follows: One two-ounce piece in a hill, 195.2 bushels; two one-ounce pieces in a hill, 182.9 bushels; and four one-half ounce pieces in a hill, 162.4 bushels per acre. The cutting of a potato tends to increase the number of stems produced, and when from two to four potato sets are planted in one place there is a greater number of stems produced than where one large piece is used. Evidently a few large, vigorous stems give better results than a large number of small, weakly stems, which are almost sure to grow where more than one piece is planted in each hill.

METHODS OF PLANTING POTATOES. Some farmers favor planting potatoes in rows 25 to 30 inches apart; while others favor planting in squares, or hills, from 30 to 40 inches apart both ways. An experiment has been conducted in our experimental grounds for seven years in succession, in order to compare the results of planting potatoes in rows three and a third links (26 2-5 inches) apart and having the potato sets one foot apart in the row in comparison with planting the potato sets in squares 33 inches apart both ways. The same amount of seed was used in each method, and the experiment was conducted in duplicate each year. The average results for seven years show, that the potatoes which were planted in rows gave 179.6 bushels, and those planted in squares gave 152.3 bushels per acre.

CORN FOR FODDER AND FOR THE SILO.

There has not been much variation in the area devoted to fodder and silage corn in Ontario within the last few years. The average for the last two years, however, is about nineteen per cent. greater than for the past twenty-three years.

VARIETIES. It should be quite evident to a person familiar with the growth of fodder and silage corn throughout Ontario that no one variety is equally suited to all parts of the Province. It is also a fact that some of the varieties which give the best results in the middle

States of the American Union are entirely unsuited for cultivation in Ontario, owing to the shorter season of growth in Ontario as compared with that in some of the central States. Hence, the importance of testing a large number of varieties under similar conditions to ascertain not only the total yield of crop per acre but also the yield of ears or grain and the comparative earliness or lateness of the different varieties. In securing a suitable corn for the silo or for use as green or dry fodder, it is important to select a variety that produces a large total yield per acre and also gives a large yield of grain, and reaches a fair stage of maturity before the first nipping frosts occur in the locality where it is grown. Keeping these three points in view in experiments which have been conducted with a large number of varieties of corn for several years in succession, we have found that the Mammoth Cuban, Mastadon Dent, and Leaming are varieties which generally give good satisfaction on the warm soils of the southern part of Ontario, where large varieties of corn can be grown successfully; that the Wisconsin Earliest White Dent and the White Cap Yellow Dent give a good yield of total crop per acre which is of excellent quality, both of these varieties producing large yields of ears, and being specially suited to the central part of the Province where the frosts are not too severe; and that the King Phillip, Salzer's North Dakota, and Compton's Early varieties generally give good satisfaction in those parts of Ontario where the frosts are apt to occur at an early date. Of the one hundred and three varieties grown in the Experimental Department in 1904, the largest yields of ears per acre were produced by the following kinds: Early Windsor Sweet, 5.2 tons; Kendal's Early Giant Sweet, 5.2 tons; Ringleader Sweet, 5.0 tons; and Winconsin Beauty Sweet, 4.9 tons per acre. It will therefore be seen that the four varieties which have produced the greatest yields of ears per acre in 1904 were all sweet corns. These varieties are suitable for fodder purposes, but are not considered as valuable for silage as some of the Dent corns.

METHODS OF CULTIVATION. In 1902, 1903, and again in 1904, an experiment was conducted by cultivating corn in four different ways. The North Star Yellow Dent variety of corn was used in the experiment in 1902 and in 1903, and the White Cap Yellow Dent and King Phillip varieties in 1904. Each test consisted of four plots. The experiment was conducted in duplicate each year. The average results of the six tests conducted within the last three years are as follows: (1) Deep cultivation at first gradually getting shallower as the season advanced, 21.9 tons; (2) Shallow cultivation throughout the season, 21.2 tons; (3) Deep cultivation throughout the season, 20.8 tons; and (4) Shallow cultivation at first gradually getting deeper as the season advanced, 20.5 tons per acre. From these results, it will be seen that, in seasons such as we have had in the past three years, corn which was cultivated deeply immediately after it was planted and in which the cultivation was made shallower as the season advanced produced the

greatest yield; while that which was cultivated shallow at first and deeper as the season passed by produced a lighter yield by fully one ton per acre.

SORGHUM FOR FODDER.

Eighteen varieties of sorghum were grown in the experimental grounds in 1904. These included different varieties of sugar cane, broom corn, kaffir corn, millo maize, etc. The greatest yields in the past season were produced by the following varieties: Orange Sugar Cane, 20.5 tons; Earliest Black Sugar Cane, 18.8 tons; Kenney's Improved Amber Sugar Cane, 18.1 tons; Folger Cane, 16.3 tons; and Early Minnesota Sugar Cane, 15.4 tons per acre. The greatest yields of heads in 1904 were produced by the Australian Broom Corn, 1.7 tons; California Golden Broom Corn, 1.6 tons; Dwarf Broom Corn, 1.6 tons; and Kenney's Improved Amber Sugar Cane, 1.5 tons per acre. In the average of eleven varieties grown for six years in succession, the highest yields of total crop per acre were produced by the Early Minnesota Sugar Cane, 16.6 tons; Orange Sugar Cane, 16.4 tons; Fodder Cane, 13.5 tons; Early Amber Sugar Cane, 13.3 tons; and Kaffir Corn, 11.2 tons per acre.

SUNFLOWERS FOR FODDER.

As considerable has been said regarding the practice of growing sunflowers and using the heads for cutting with corn for the silo, and as some farmers are growing sunflowers for this purpose, experiments have been conducted with several varieties within the past ten or twelve years in order to glean fuller information regarding the comparative value of the different varieties. Two varieties have now been under uniform tests for ten years in succession and have produced the following averages in tons of whole crop and of heads per acre: Black Giant, 19.8 and 5.8; and Mammoth Russian, 16.1 and 5.4, respectively. The White Beauty, which has been grown for seven years in succession, has produced an average of 16 tons of total crop and 5.8 tons of heads per acre. The results for 1904 were very high, showing a record for the Black Giant of 31.9 tons of total crop and 8.5 tons of heads per acre.

MILLET FOR GREEN FODDER AND FOR HAY.

Twenty-five varieties of millet were grown in the Experimental Department in 1904, and determinations were made regarding the relative yields of green fodder and of hay. The results show us that the greatest yields of green crop were produced by the Japanese Panicle, 12.2 tons; East India Pearl, 10.7 tons; Early Harvest, 9.3 tons; Steel Trust, 9.2 tons; and Japanese Barnyard, 8.4 tons per acre. In comparison with these, the Hungarian Grass produced 8.2 tons of

green crop. The Pencilaria produced 10.5 tons per acre, but no mention was made of this when giving the different varieties, as it is simply another name of the East India Pearl Millet. The greatest yields of hay in 1904 were produced by the Japanese Panicle, 4.5, and the Japanese Barnyard, 3.7 tons per acre.

As twelve of the varieties of millet have been grown for ten years in succession, the experiments cover a great variety of seasons. Those varieties producing large yields of green crop and of hay per acre are as follows: Golden Wonder, 11.2 tons of green crop and 4.5 tons of hay; Holy Terror Gold Mine, 10.8 tons of green crop and 4.5 tons of hay; Japanese Panicle, 10.1 tons of green crop and 4.5 tons of hay; Magic, 9.9 tons of green crop and 4.2 tons of hay; and Japanese Barnyard, 9.5 tons of green crop and 4 tons of hay per acre.

RAPE, KALE, CABBAGE, ETC.

Although rape is known more or less throughout Ontario, neither cabbage or kale has been grown as a field crop on many of our farms for the purpose of furnishing food for farm stock. All these crops are grown more extensively in Great Britain than they are in Canada. Experiments have now been conducted in each of the past six years with fifteen varieties of rape, kale, cabbage, etc., in order to glean some information regarding the comparative yields of these varieties when grown under uniform conditions in Ontario. The seed has been sown in rows about 26 inches apart, and the land has been cultivated in much the same way as that containing a crop of turnips. Only about one pound of seed per acre is required when sown in rows and the land cultivated. The seeding has usually been done in June, and the crop harvested the latter part of September or in October. The following table gives the names of the varieties, the yield per acre in 1904, and the average yield per acre for six years of each of fifteen varieties:

Varieties.	Yield per acre in 1904.	Average yield per acre for 6 years.
	Tons.	Tons.
Sutton's Earliest Drumhead Cabbage	24.5	19.9
Dwarf Essex Rape	14.9	17.4
Thousand Headed Kale	19.0	17.1
Dwarf Victoria Rape	12.3	17.0
Marrow Stem Kale	21.0	16.8
Purple Sprouting Boroccoli	18.5	16.6
Sutton's Earliest Sheepfold Cabbage	25.0	16.2
Marrow Collards	22.7	15.7
Hardy Curled Kale	15.2	15.6
Sutton's Best of All Savoy Cabbage	18.3	14.9
Jersey Kale	15.4	14.8
Sutton's Latest Drumhead Cabbage	18.0	12.2
Tall Green Curled Scotch Kale	12.5	12.1
Brussels Sprouts	15.2	11.6
Tall Jersey Cabbage	2.9	7.8

It will be noticed that the two varieties of rape gave exceptionally low results in 1904. Among eighteen varieties of rape, kale, cabbage, etc., which have been grown for less than six years, the greatest yields in 1904 were as follows: Sutton's Giant Drumhead Cabbage, 24.4 tons; Large Seeded Common Rape, 20.8 tons; Large Seeded Umbrella Rape, 20.6 tons; Hammond's English Rape, 20 tons; Garton's Improved Thousand Headed Kale, 19.3 tons; and Buckbee's Wonderful Dwarf Bonanza Rape, 18.5 tons per acre. For a free donation of seed of several new varieties of rape, we are indebted to Mr. Dicks, of the Cooper-Taber Seed Growers, England.

GREEN FODDER CROPS.

Fifteen varieties of leguminous crops, including vetches, Soy beans, Cow peas, etc., have been grown in the experimental plots for four years in succession. As much interest has been taken in recent years in some of these crops, a table, giving the results of all the different crops which were grown under similar conditions, furnishes both interesting and valuable information.

Varieties.	Average for 4 years.	
	Length of plants.	Yield of green crop per acre.
	Inches.	Tons.
Medium Green Soy Beans	32.0	11.0
Hairy Vetches	33.5	10.2
Common Vetches .....	.....	8.7
Early Yellow Soy Beans	27.0	8.5
Grass Peas	38.5	7.9
Horse Beans	31.0	6.7
American Coffee Berry	22.0	6.4
Wonderful Cow Peas	16.8	5.2
Extra Early Blackeye Cow Peas	16.8	5.0
Taylor Cow Peas	13.5	4.9
Whip-poor-will Cow Peas	14.3	4.4
New Era Cow Peas	13.5	4.4
Warren's Extra Early Cow Peas	13.0	3.7
Extra Early Dwarf Soy Beans	19.0	2.6
Velvet Beans	14.8	1.8

The Medium Green Soy beans, which stood first in the accompanying table in yield per acre, are an exceptionally fine variety, and, we believe, will be grown more and more for the production of fodder for feeding in the autumn or for mixing with corn when filling the silo, in order to increase the quality of the silage. If the Medium Green Soy beans are sown in rows 30 inches apart with the beans 8 inches apart in the row, at the time when the corn is planted, the crop will usually be ready for mixing with the corn for putting in the silo when the corn is in the best condition. The Hairy Vetches, as a rule, produce fully 4 tons per acre more than the Common Vetches, as shown by the results of these varieties which have been grown side by side for eight

years in succession. The Grass peas have given very good results as a green crop in each of the past three years, but, owing to the peculiar conditions of the weather during the summers of 1902, 1903, and 1904, the Grass peas have not ripened as satisfactorily as they did in previous years. The varieties of Cow peas are not, as a rule, suitable for the production of either grain or fodder when grown in Ontario.

No less than twenty-seven different varieties of leguminous crops were tested under similar conditions in 1904. The greatest yields during the past season were obtained from the following varieties: Grass peas, 10.2 tons; Medium Green Soy beans, 9.5 tons; Ito San Soy beans, 8 tons; and Early Yellow Soy beans, 7.8 tons per acre.

WINTER SOWING OF WINTER RYE, HAIRY VETCHES, AND CRIMSON CLOVER, FOR FODDER PRODUCTION.

In the autumn of 1903, plots were sown with Winter Rye, Hairy Vetches, and Crimson Clover, with the object of ascertaining the comparative yields of green fodder produced from these crops in the following season. The Crimson Clover, however, was completely winter killed. Both the Winter Rye and the Hairy Vetches survived the winter in fairly good condition. Each crop was cut in 1904 when in its best condition as green fodder, the Winter Rye producing 15.2 and the Hairy Vetches, 12.1 tons of green crop per acre.

THE WILD VETCH AS A FODDER CROP.

In the spring of 1902, Mr. F. W. Hodson, Live Stock Commissioner for Canada, forwarded some seed of the wild vetch, which is frequently observed growing in uncultivated land and especially along the railroads. The seed was sown in the spring of 1902, but the growth was exceedingly small in the following season. In 1903 the crop was also light, but in 1904 it took complete possession of the land, forming a network of roots and producing 7.6 tons of green crop per acre. It is quite probable that this would form a bad weed if used in regular rotations, but it might prove serviceable for sowing on rough land where grass and clover do not thrive and where a permanent crop is desired.

ANNUAL CROPS FOR PASTURE PURPOSES.

An experiment was conducted in 1900 and repeated in 1901, 1902, and in 1904, with the object of finding out which one of a number of annual crops would give the best results when used for pasture in the same year in which it is sown. For this experiment, fourteen varieties have been used. In each of the years, the crops were sown in three separate sets, there being fourteen plots in each set, thus making in all a total of forty-two plots each season. All the plots were sown

each year on the same day and under similar conditions. The seed was sown in May in each of the four seasons. The three sets were handled in each year as follows :

Set. 1. The crops on all the plots in Set 1 were cut at the end of six, nine, twelve, fifteen, and eighteen weeks after the seed was sown, thus making five cuttings for each crop. Each cutting was weighed in the green state, and also after it was dried in the form of hay.

Set 2. Each crop was cut when it was thought to contain the greatest bulk of best quality of green fodder. In order to ascertain the aftergrowth, another cutting was also made from each plot later in the season.

Set 3. A hurdle fence was placed around the set of eighteen plots, and cattle were turned on the plots daily until the pasture was all eaten. The first pasturing took place in the latter part of June and the early part of July. Careful notes were taken of the amount eaten of each crop each day. After the crops were pastured the first time, they were allowed to remain undisturbed until the autumn, when the cattle were again turned on, and the second growth was eaten off.

The average results for the four years, representing the yield of pasture for each of the five cuttings for the various crops under experiment, are here presented :

Crops.	Tons of green pasture per acre at each of five cuttings per annum. Average of four years.					Total number of tons per acre per annum in five cuttings.
	1st cutting.	2nd cutting.	3rd cutting.	4th cutting.	5th cutting.	
	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
1. Hairy Vetches	1.20	3.28	1.35	1.25	.85	7.93
2. Common Red Clover.....	.06	1.91	2.09	1.69	1.61	7.36
3. Siberian Oats.....	3.45	1.76	1.32	.40	.38	7.31
4. Crimson Clover.....	.05	2.64	1.76	.97	1.79	7.21
5. Early Amber Sugar Cane	.14	2.04	2.63	.97	.91	6.69
6. Spring Rye	5.07	.55	.35	.09	.09	6.15
7. Common Vetches	1.73	1.97	1.10	.63	.62	6.05
8. Dwarf Essex Rape	.58	2.56	1.26	.65	.80	5.85
9. Mandscheuri Barley	3.65	.85	.59	.09	.20	5.38
10. Hungarian Grass.....	1.23	1.79	1.38	.68	.28	5.36
11. Compton's Early Corn	.95	2.46	1.04	.35	.01	4.81
12. Grass Peas	1.68	2.06	.83	.17	.03	4.77
13. Wild Goose Spring Wheat	2.23	1.03	.90	.15	.17	4.48
14. Soy Beans	.73	1.27	.63	.37	.21	3.21

As the result of experiments previous to 1904, six different mixtures were formed and sown on different plots in the spring of the present year. The experiment was conducted in duplicate. The average yield of pasture produced from the five cuttings of each of the duplicate sets of the six mixtures are as follows : (1) Crimson Clover, Hairy Vetches, and Siberian Oats :—8.2 tons ; (2) Hairy Vetches, Siberian Oats, and Early Amber Sugar Cane :—8.0 tons ; (3) Siberian Oats, Early Amber Sugar Cane, and Common Red Clover :—8.0 tons ; (4)

Common Red Clover, Emmer, and Hungarian Grass:—5.9 tons; (5) Early Amber Sugar Cane, Common Red Clover, and Emmer:—5.7 tons; and (6) Emmer, Hungarian Grass, and Spring Rye:—5.2 tons per acre. From a study of the results under this heading, it will be seen that a mixture of annual crops is likely to give a more satisfactory pasture during the same year it is sown than any of the crops when sown by themselves.

GRASSES AND CLOVERS.

Of all the farm crops grown in Ontario, we believe there are none so important as the grasses and clovers used for hay and for pasture. Nearly six million acres of Ontario land are devoted annually to the production of hay and pasture; hence, the great importance of the farmers in this Province giving close attention to the different varieties of grasses and clovers for growing singly and in various combinations for the production of either hay or pasture.

VARIETIES OF GRASSES FOR THE PRODUCTION OF HAY. Fifteen varieties of grasses, including some of our best native as well as some of the most noted European kinds, have been carefully tested in the Experimental department in each of seven different years. The grasses have usually been sown in the spring of the year with a light seeding of grain, as, for instance, one bushel of barley or a bushel and a peck of oats per acre. In the following and succeeding years, careful records have been made regarding the height of the different crops, the date at which they reached the proper condition to cut for hay, and the yield per acre of each cutting in each season. The following table gives the common and scientific names of the different varieties, the average date and height of the first cutting, and the total annual yield of hay per acre of each of fifteen varieties, these results being obtained from seven different years and from three separate seedings:

Common name.	Scientific name.	Date of first cutting, average 3 years.	Height of first cutting, average 7 years.	Total annual yield of hay per acre, average 7 years.
			Inches.	Tons.
1. Western Rye	<i>Agropyron tenerum</i>	July 12	31	4.36
2. Lyme Grass	<i>Elymus virginicus</i>	" 25	33	4.31
3. Fringed Brome	<i>Bromus ciliatus</i>	" 30	36	3.80
4. Timothy	<i>Phleum pratense</i>	" 7	35	3.47
5. Bearded Wheat	<i>Agropyron caninum</i>	" 26	35	3.27
6. Canadian Lyme	<i>Elymus canadensis</i>	" 27	32	3.25
7. Tall Oat	<i>Arrhenatherum avenaceum</i> ..	June 26	43	2.76
8. Orchard	<i>Dactylis glomerata</i>	" 27	34	2.55
9. Meadow Fescue	<i>Festuca pratensis</i>	July 1	32	2.23
10. Awnless Brome	<i>Bromus inermis</i>	" 7	26	2.18
11. Rhode Island Bent	<i>Agrostis canina</i>	" 13	25	1.97
12. Red Top	<i>Agrostis vulgaris</i>	" 9	23	1.79
13. Kentucky Blue	<i>Poa pratensis</i>	June 26	24	1.58
14. Meadow Foxtail	<i>Alopecurus pratensis</i>	" 22	31	1.55
15. Perennial Rye	<i>Lolium perenne</i>	" 29	20	1.25

The Western Rye, Lyme Grass, and Fringed Brome, which stand at the head of the list in yield of hay per acre, are all natives of Canada and have not yet been brought into field cultivation in Ontario. The Western Rye Grass which produced on an average nearly 4 1-2 tons of hay per acre is quite promising. Dr. Jas. Fletcher, Botanist at the Central Experimental Farm, Ottawa, in referring to the Western Rye Grass in his report for 1898, states that it has given most satisfactory results as a hay and pasture grass, and also states that Mr. S. A. Bedford, Superintendent of the Brandon Experimental Farm, who has grown the Western Rye Grass for many years, has always spoken of it in the highest terms. It is highly spoken of by Mr. Angus McKay of the Experimental Farm at Indian Head. In the report of the Dominion Experimental Farms for 1901, Dr. Fletcher states that "the Western Rye Grass, a native of the prairie regions, is a most valuable grass, and is now much cultivated for its rich and heavy crops of hay and seed." It will be seen from the table here presented that the varieties which are ready for cutting for hay production at the earliest dates are the Meadow Foxtail Grass, Tall Oat Grass, Kentucky Blue Grass, Orchard Grass, and Perennial Rye Grass, each of these varieties being usually cut in the latter part of June. The varieties here mentioned are from one to two weeks earlier than timothy; while the Lyme Grass, Fringed Brome Grass, Bearded Wheat, and Canadian Lyme are about three weeks later than timothy in reaching the proper stage for cutting as hay.

VARIETIES OF GRASSES FOR THE PRODUCTION OF PASTURE. It is indeed a difficult matter to make an exact comparison of a number of different kinds of grasses for pasture purposes. In experiments conducted for many years in England at Woburn in connection with the Royal Agricultural Society, as well as at other places, it is found unwise to attempt to compare different grass lands by having the crops pastured by sheep, unless at least three acres are used in each plot. If cattle were pastured on it, even larger plots than these would be necessary. It will therefore be seen that if a person wished to make a comparison of fifteen or twenty separate kinds of grasses for pasturing sheep or cattle, a very large amount of land would be necessary. It was thought, however, that some valuable information might be obtained by using smaller plots of land, and by cutting, weighing, and removing the crops from the land, instead of pasturing them with farm stock. An experiment has been conducted, therefore, for four years in succession, by cutting each of sixteen varieties of grasses at that time in the spring when the earliest varieties were ready for pasturing, and then cutting, weighing, and removing the crops produced by each of the varieties at each time during the summer when the more vigorous varieties had produced a sufficient growth for furnishing a good pasture crop. The following table gives the average of the four years'

results of sixteen varieties of grasses at each of six different cuttings, as well as the total number of tons of pasture per acre per annum :

Varieties.	Tons of green pasture per acre, at each of six cuttings per annum. Average of four years.						Total number of tons per acre per annum in six cuttings.
	1st cutting.	2nd cutting.	3rd cutting.	4th cutting.	5th cutting.	6th cutting.	
	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
1. Tall Oat	5.93	.83	1.59	1.23	1.33	.87	11.8
2. Orchard	4.34	1.71	.92	1.30	1.05	1.40	10.7
3. Western Rye	4.82	1.28	.93	1.58	.89	.64	10.1
4. Canadian Lyme	3.67	1.81	1.01	1.82	1.01	.73	10.1
5. Bearded Wheat	3.18	1.78	1.03	1.89	1.11	.79	9.8
6. Meadow Fescue	4.60	1.72	.69	1.09	.84	.61	9.6
7. Virginia Lyme	4.13	1.32	.87	1.65	.86	.62	9.5
8. Tall Fescue	4.70	1.75	.78	.87	.74	.59	9.4
9. Timothy	4.87	1.71	.58	1.11	.62	.49	9.4
10. Fringed Brome	4.27	.80	1.09	1.55	.98	.58	9.3
11. Awnless Brome	4.53	.96	1.04	1.26	.63	.62	9.0
12. Perennial Rye	4.10	1.49	.61	.78	.90	.80	8.7
13. Meadow Foxtail	3.81	1.32	.72	.95	.53	.37	7.7
14. Kentucky Blue	3.76	1.04	.73	.78	.58	.58	7.5
15. Rhode Island Bent	3.17	1.17	.66	.91	.52	.40	6.8
16. Red Top	2.71	1.03	.62	.67	.44	.37	5.8

It will be seen that the Tall Oat Grass produced the grèatest amount of pasture crop per acre, the average for the four years being nearly 12 tons per acre. It gave decidedly the largest yield at the first cutting, held out well in the middle of the summer, and furnished a fairly large amount of pasture crop in the autumn of the year. The Orchard Grass was especially strong in the autumn, producing the grèatest quantity of pasture crop at the last cutting of the sixteen varieties of grasses under experiment. Although the Western Rye, Canadian Lyme, and Bearded Wheat have all given comparatively high results in yield of pasture crop per acre, a study of the experiment shows us that when these crops are cut six times during the season, the vitality of the plants becomes greatly exhausted and the crops are apt to be quite inferior in the following season. In the case of the Tall Oat, Orchard Grass, Meadow Fescue, and Tall Fescue, however, the vitality of the plants does not seem to be injured to any great extent by frequent cutting. The results of this experiment are very suggestive, and, we believe, furnish some valuable information regarding the special characteristics of different varieties of grasses when grown with the object of pasture. As a result of this experiment, we are obtaining valuable suggestions as to the most suitable combinations of grasses to use for permanent pastures.

VARIETIES OF CLOVERS FOR THE PRODUCTION OF HAY. A number of varieties of clover have been grown in the Experimental Department for the production of hay, but it has been difficult to get the results of a large number of varieties of clover under uniform conditions for a series of years. We are, however, presenting the average results of each of three varieties for a period of six years. The following table

gives the average date of the first cutting for four years, the average height of the first cutting for six years, and the total annual yield of hay per acre for the average of six years.

Varieties.	Date of first cutting, average 4 years.	Height of first cutting, average 6 years.	Total annual yield of Hay per acre, average 6 years.
		Inches.	Tons.
Alsike	July 3	20	3.47
Mammoth Red.....	" 11	25	3.31
Common Red	June 27	22	2.95

It will be seen that in the average of four years' experiments the Common Red clover was ready to cut on the 27th of June, the Alsike clover on the 3rd of July, and the Mammoth Red clover on the 11th of July. According to this report, the first cutting of the Mammoth Red clover was exactly two weeks later than that of the Common Red variety. The Alsike clover, although producing the shortest plants in the first cutting, gave the largest average yield of hay per acre. It furnishes a close mat of growth. The Mammoth Red clover produces a large crop at the first cutting, but neither this variety nor the Alsike clover furnishes much of a second growth. In 1904 both the Alsike and the Mammoth Red varieties gave exceptionally high yields of hay per acre.

VARIETIES OF CLOVER FOR THE PRODUCTION OF PASTURE An experiment has been conducted for three years by cutting each of eight varieties of clover and similar crops at five different times during the growing season, in order to ascertain the amount of pasture crop produced by each variety throughout the summer. The first cutting was made as soon as the earliest varieties had made sufficient growth to furnish a good pasture. Each of the other five cuttings were made at such times as the most vigorous growing varieties had produced sufficient growth for pasture purposes. As each cutting was made, the crop was weighed immediately in order to ascertain the exact yield of pasture crop produced by each variety. The following table gives the average results for three years of each of the six cuttings per annum of each variety:

Varieties.	Tons of green pasture per acre, at each of six cuttings per annum. Average of three years.						Total number of tons per acre per annum in six cuttings.
	1st cutting.	2nd cutting.	3rd cutting.	4th cutting.	5th cutting.	6th cutting.	
	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
1. Lucerne.....	8.73	3.06	2.70	3.62	1.56	1.27	20.9
2. Common Red	10.88	1.10	2.37	3.39	1.52	1.15	20.4
3. Mammoth Red	10.55	1.02	1.99	2.83	1.19	1.19	18.8
4. White or Dutch	7.35	2.35	1.95	1.91	2.08	1.63	17.3
5. Alsike.....	8.22	.28	3.06	1.41	2.56	.93	16.5
6. Yellow Trefoil	5.07	.19	2.59	2.18	2.10	1.02	13.2
7. Sainfoin.....	4.64	.67	1.78	2.73	1.19	.79	11.8
8. Burnet	2.64	1.39	1.05	1.52	.59	.41	7.6

According to the results here presented in tabulated form it will be seen that upwards of 20 tons per annum of green pasture crop per acre were produced by Lucerne and also by the Common Red clover. Each of these yields is about double that of Tall Oat grass and of Orchard grass previously reported. The White or Dutch clover made a high record, producing over 17 tons of green pasture crop per acre per annum. Although this clover does not produce a very large amount of hay, it will be seen that it furnishes a large amount of pasture, as it forms an exceedingly compact mass near the surface of the ground. The results which are here presented should be considered in connection with the results previously reported under the heading of "Varieties of Grasses for the Production of Pasture."

MIXTURES OF HARDY GRASSES AND CLOVERS FOR THE PRODUCTION OF EITHER HAY OR PASTURE. A large amount of experimental work has been done in testing varieties of grasses and clovers, both singly and in combination, within the past twenty-seven years. The grasses and clovers have been carefully studied, and much information has been gleaned in regard to their value, for hay and also for pasture. In 1885, Prof. Wm. Brown, who was then Farm Superintendent at the Ontario Agricultural College, recommended a mixture which he thought well adapted for permanent pasture. Only the most hardy varieties which had been tested up to that time were included in the mixture. In 1893, after eight years of additional experimental work, during which time the writer was closely connected with the work of the Experimental

Grasses and Clovers.	Varieties in mixtures.	Amount of seed per acre.	Average height of 1st cutting for 10 years.	Yield of hay per acre.	
				1904, 2 cuttings.	Average for 10 years, 23 cuttings.
1885.		Lbs.	Inches.	Tons.	Tons.
Grasses	Meadow Fescue	6	33.2	4.16	4.44
"	Meadow Foxtail	3			
"	English Rye	2			
"	Timothy	3			
"	Canadian Blue	4			
"	Orchard	3			
"	Red Top	2			
"	Yellow Oat	2			
Clovers	Lucerne	4			
"	White or Dutch	2			
"	Alsike	2	37.0	4.64	5.09
"	Red	1			
"	Yellow or Trefoil	1			
		35			
1893.					
Grasses	Orchard	4	37.0	4.64	5.09
"	Meadow Fescue	4			
"	Tall Oat	3			
"	Timothy	2			
"	Meadow Foxtail	2			
Clovers	Lucerne	5			
"	Alsike	2			
"	White or Dutch	1			
"	Yellow or Trefoil	1			
		24			

Department, another mixture was recommended containing a smaller number of varieties and requiring a smaller amount of seed per acre. The grasses and clovers recommended in 1893 have proven themselves to be a valuable mixture. They are all hardy varieties, and when grown together give a large yield. An experiment was started in the spring of 1894 by sowing a plot of the mixture which was recommended in 1885, and a plot of the mixture which was recommended in 1893. The seed was sown with a light seeding of barley; and the germination of the seed of the grasses and clovers was quite satisfactory.

From two to three cuttings have been secured in each of the ten years from 1895 to 1904, inclusive. In 1904, which is the eleventh year since the plots were sown, two cuttings were taken from each plot. The total yield of hay produced from the two cuttings was 4.64 tons from the mixture recommended in 1893, and 4.16 tons from the mixture recommended in 1885. The figures represented in this report show the comparative yields of hay from the two mixtures; they also show that the grasses used for the mixtures are very suitable for an average soil in Ontario. These mixtures can be used for the production of either hay or pasture, but are more suitable for pasture purposes, owing to the unevenness in the maturity of the different varieties, which is a detriment to hay production but an advantage when the crop is used for pasture purposes. Without a single exception, the mixture which was recommended in 1893 has produced a larger yield per acre than that which was recommended in 1885. We have named all the varieties of grasses and clovers sown in each mixture, and also the quantity of seed per acre, in order to make the experiment as clear as possible, and also to furnish a guide for any person who wishes to know the quantity of seed per acre of the different varieties which are recommended as a permanent pasture mixture for an average Ontario soil. It will be observed that the mixture recommended in 1893 possessed none but very hardy grasses and clovers which have been tested at the College more or less for about twenty-six years. This mixture could, of course, be somewhat modified to suit different localities and different soils.

CONTENTS.

Experimental Work at the Agricultural College.....	1
Results of Experiments.....	1
Conditions of the weather during the past Summer.....	2
Fluctuations in the Areas of Farm Crops in Ontario.....	3
Yields per acre of different classes of grain.....	4
Barley	6
Oats.....	11
Wheat.....	16
Rye	22
Buckwheat	22
Field Peas.....	23
Field Beans.....	25
Soy, Soja or Japanese Beans.....	26
Horse Beans.....	26
Grass Peas.....	26
Cow Peas.....	27
Hairy Vetches for Seed.....	27
Alfalfa for Seed Production.....	27
Corn for Grain.....	27
Sorghum for Seed.....	28
Millet for Seed.....	28
Sunflower Seed.....	28
Flax Seed	28
Sowing Spring Grains on Six Different Dates.....	29
Growing Grains in Mixtures for the Production of Grain and Straw.....	31
Mangels	33
Sugar Beets.....	35
Field Carrots.....	39
Swede Turnips.....	40
Fall Turnips.....	41
Parsnips.....	43
Kohl Rabi.....	43
Potatoes	44
Corn for Fodder and for the Silo.....	50
Sorghum for Fodder	52
Sunflowers for Fodder.....	52
Millet for Green Fodder and for Hay.....	52
Rape, Kale, Cabbage, etc.....	53
Green Fodder Crops	54
Winter Sowing of Winter Rye, Hairy Vetches. and Crimson Clover for Fodder Production.....	55
The Wild Vetch as a Fodder Crop.....	55
Annual Crops for Pasture Purposes.....	55
Grasses and Clovers.....	57

ONTARIO AGRICULTURAL COLLEGE AND EXPERIMENTAL FARM

GAS-PRODUCING BACTERIA AND THEIR EFFECT ON MILK
AND ITS PRODUCTS.

By F. C. HARRISON, Professor of Bacteriology.

One of the commonest troubles in a cheese factory is the affection known to cheesemakers as "gassy" milk, which gives rise to off-flavors, and swelling and huffing of the cheese, and whilst it is impossible to give figures showing the financial loss by depreciation in the value of such tainted cheese, we know that such losses are frequently very serious.

Considering the importance of the bacteria which induce these changes in milk, very little attention has been given them by American bacteriologists, but in Europe, a number of valuable investigations have been made but under conditions which are very different from our own. On this account, a number of experiments were planned and carried out in the Bacteriological Laboratory of the College, aided by the facilities afforded by the College cheese factory.

Many of the details of these experiments are of a technical nature, dealing with the peculiarities of the shape, structure, and growth of the sixty-six varieties of gas-producing bacteria isolated from various sources. No mention will be made of these in this bulletin, but, in addition to the scientific data, a number of practical points were investigated which are now set forth in this bulletin.

The gas-producing bacteria were isolated from the milk supplied to the College Dairy by farmers in the vicinity. This milk compared favorably with the ordinary factory supply, as constant endeavors have been made to instruct the patrons in the most approved manner of handling their milk. In spite of this fact, the College cheesemaker is very often bothered with gassy fermentations in the curd and cheese, and this investigation was undertaken in order to find out the habitat, ascertain the number and study the effects of the various species of gas-producing bacteria present in milk and cheese.

Samples of milk were taken in sterile tubes from the mixed milk of each farmer, and immediately brought to the laboratory and analysed. This sample, after taking out the quantity that was used for the analysis, was kept for a day or two at blood temperature in order to ascertain if gas was produced. Occasionally, we found gas bubbles in the milk sample, but no gas-producing bacteria developed in the gelatine plates, a probable proof of the small number of this class of organisms in the sample at the time the examination was made.

The samples of milk from some farms always showed gas, whilst from others it was only occasionally present, and a few samples never showed a trace. On the hottest days the number of gas-producing bacteria was often very large, whilst on cooler days the number present was always very small.

From a number of samples of milk obtained from other sources, we isolated gas-producing bacteria, but these samples were not so fresh as those we collected at the Dairy. The following table shows the results of the examination of milk from the College Dairy herd and from the mixed milk of farmers supplying the factory. A perusal of this table shows that for the 27 examinations here recorded the percentage of gas-producing bacteria varied from a fraction of one per cent. to over 34 per cent., with an average of 4.67. This table by no means represents the total number of examinations made, as in nearly every case each farmer's milk was examined from three to seven times.

Source.	Total No. of Bacteria per cu- bic centimetre, (16 drops.)	No. of Gas-pro- ducing Bac- teria per c c. (16 drops.)	Percentage.
Dairy Herd.....	1,915,000	46,000	2.4
Farmer H.....	30,000,000	12,900	0.043
“ “.....	7,000,000	123,000	1.7
“ “.....	807,000	2,000	0.2
Farm Department.....	1,750,000	5,120	0.2
“ “.....	208,000	16,000	7.6
Farmer G.....	40,600,000	96,000	0.2
“ Gn.....	539,000	154,300	28.6
“ H.....	49,000,000	112,000	0.2
“ “.....	714,000	3,840	0.5
“ D.....	360,000	1,200	0.3
“ L.....	3,240,000	77,500	2.3
Dairy Herd.....	7,737,000	6,240	0.08
“ “.....	432,000	2,400	0.5
“ “.....	3,000,000	333,600	11.1
Farmer M.....	17,000,000	153,000	0.9
“ “.....	29,000,000	3,200	0.011
“ “.....	101,000,000	43,000	0.04
“ McD.....	3,494,000	112,000	3.2
“ “.....	9,885,000	3,397,000	34.2
“ H.....	77,000,000	448,000	0.53
“ P.....	4,170,000	794,440	19.0
“ “.....	270,000	9,000	3.3
“ “.....	446,000	2,880	0.6
“ R. L.....	5,000,000	100,000	2.0
“ “.....	5,654,000	260,000	4.5
“ L.....	1,872,000	36,000	1.92
Average.	14,892,333	235,208	4.67

Having ascertained the fact that numerous gas-producing bacteria were present in the milk as delivered at the factory, the next step was to try to find out how the gas-producing organisms got into the milk.

Some investigators have shown that the milk before it leaves the udder may be contaminated with bacteria, and further that these bacteria were occasionally gas-producing organisms. There is also a well known fact that inflammation of the udder (mastitis) is, at times, caused by gas-producing bacteria. Taking every possible precaution to guard against the entrance of germs from the air, and from the hairy coat of the animal, we examined the milk from the 25 cows comprising the Dairy herd, and from the milk of two of them a number of gas-producing bacteria were isolated. The results of this experiment are important, because it explains why some of the factory inspectors have been able to trace gas production to a single cow in a herd.



Photograph of gelatin plate, made from a drop of milk, shewing colonies of gas-producing germs. Each white dot is called a colony, and is made up of huge numbers of individual germs, the result of the continued growth of a single germ that was in the drop of milk, and which was held in place when the gelatin solidified. Note the gas bubbles at G.

Thirteen analyses were made of the stable air, but this was remarkably pure and no gas-producing bacteria were found.

During the movements of milking, particles of skin, hair, etc., and with them bacteria, are dislodged from the animal's coat, and drop into the milk pail. We found that gas-producing bacteria were present upon the hairy coat of the animal. When the udder and flanks were wiped

with a wet cloth, these bacteria were prevented from falling into the pail, as germs are unable to leave a moist surface.

The cows drank from a wooden trough in the pasture field, and, on examination, this water was shown to contain gas-producing organisms which probably came from the soil, as the water obtained from the tap was remarkably pure, containing less than 20 bacteria per c.c. and none of these gas-producing forms.

By washing out clean, dry cans which had been cleaned in the ordinary manner with sterilized water, we obtained gas-producing bacteria.

Very many flies were present in the stable, and these frequently fell into the pail and added undesirable bacteria, which find in milk a good food for growth. A number of these flies were captured, and single flies were placed in test tubes containing a measured quantity of sterilized water and well shaken. This water on analysis was found to contain large numbers of gas-producing bacteria. Frequently, 50,000 bacteria were obtained from a single fly, and of these over 20,000 were gas-producing bacteria.

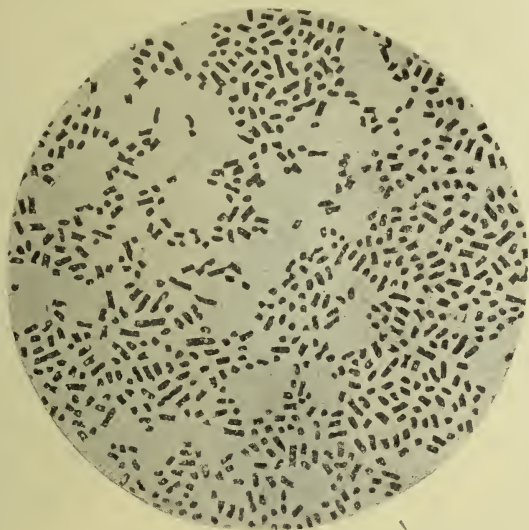
Large numbers of gas-producing bacteria were also obtained from manure. The ratio of gas-producing germs to other species in some 17 examinations was as 250 to 1. Cultures in sterilized milk made from some of these bacteria gave the peculiar odor known to cheesemakers as "gassy" milk, and others gave a characteristic "cowy" odor, although this peculiar smell has usually been ascribed to stable odors.

To summarize, gas-producing bacteria were found to be occasionally present (1) in the udders of certain cows, (2) on the hairy coat of the animal, (3) in clean, dry milk cans, (4) in the watering trough, (5) from flies, and (6) from manure. From these various locations, the gas-producing bacteria may contaminate the milk.

The gas-producing bacteria were readily killed by an exposure to temperatures ranging from 137 degrees to 146 degrees F. for 10 minutes. They were all killed by immersion in a 2 per cent. ammonia washing powder solution at 140 degrees F. and also in a 2 per cent. soda solution at 140 degrees F. for 10 minutes. These soda and ammonia washing powders are scarcely more effective than hot water for the destruction of these bacteria, but these substances aid in washing by helping to remove the dirt.

By continued growth in milk it was found that these gas-producing bacteria increased their power of fermenting the milk sugar. Thus, one variety, which originally produced 26 per cent. of gas, after growing for some time in milk produced 62 per cent.; hence those bacteria which were not killed by the hot water used in washing the cans would be more liable to produce larger quantities of gas than those which came in from other sources.

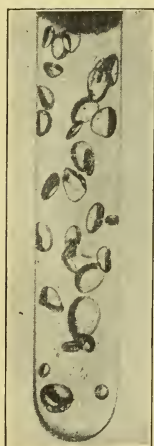
In dairy practice a starter or culture of a lactic acid bacillus is used to overcome the gassy fermentation of milk, and in order to quantitatively establish the working of this process, a number of experiments were instituted, in which gas-producing and lactic acid organisms were mixed together in order to study their antagonistic relations. The results of these experiments in general showed that the number of gas-producing germs decreased with the increase of lactic acid bacteria. Occasionally, however, some organisms were experimented with which were not so adversely influenced by the lactic acid germs.



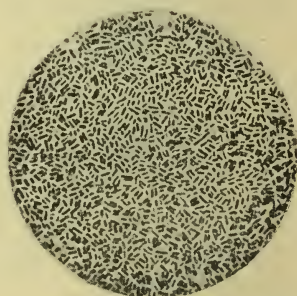
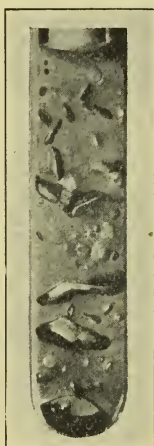
Gas-producing bacteria ; magnified 1500 diameters.

CHEESE EXPERIMENTS. A number of cheese were made from milk to which various quantities of a culture of gas-producing bacteria was added. A few of these experiments may be cited :—A cheese was made on the 5th of October from 300 pounds of milk to which 2 pounds of a 24 hour old milk culture of a gas-producing variety was added. This culture was acid, very gassy, with a bitter, astringent taste. The cheese curd was also very gassy, floating on the top of the whey. After making, the cheese was put into the curing-room with an average temperature of 55 degrees F., and bacteriological analyses were made from time to time. At the age of 21 days, the percentage of gas-producers was 76, at the end of 38 days, 71; and at the end of 52 days, 11; and at this stage, the cheese showed white and grey lines and spots, an appearance known amongst cheesemakers as "mottled." The cheese was scored, but no points could be given to it for flavor. The odor was something like rotten meat, and the mottled appearance was very striking.

A second cheese was made with a different culture of a gas-producing organism, and at the age of seven days was found to contain 15 per cent. of gas-producers. This number gradually declined, and at the age of 45 days only 2 per cent. of gas-producing bacteria were present. The cheese was examined at the end of 63 days, and was found to be slightly unpleasant in smell and taste, but was judged to be better than that made on the 5th of October, receiving 15 points out of 45 for flavor. On November 2nd, two cheeses were made. In the A cheese, $\frac{1}{2}$ per cent. of a 24 hour old milk culture of a gas-producing germ was used, and in the B cheese $\frac{1}{2}$ per cent. of the same culture and $\frac{1}{2}$ per cent. of the lactic acid bacillus. Both curds were floating about three hours from setting; the flavor was gassy. The B curd was better than the A, although even B was very



Growth of gas-producing germs in test tubes containing sugar gelatin. Note the gas bubbles.

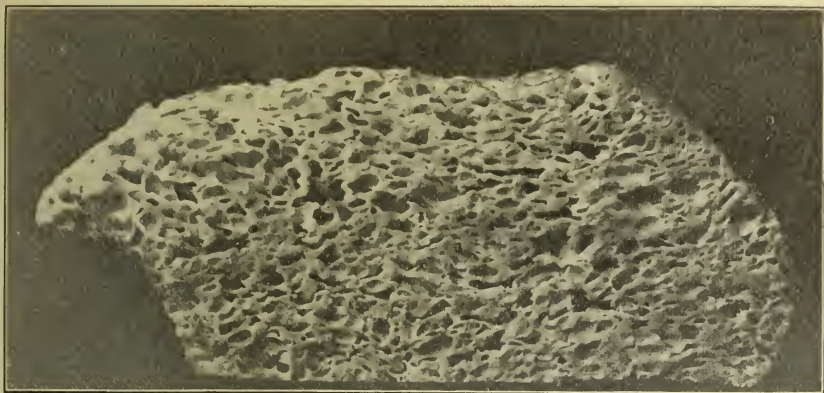


Gas-producing bacteria; magnified 1000 diameters.

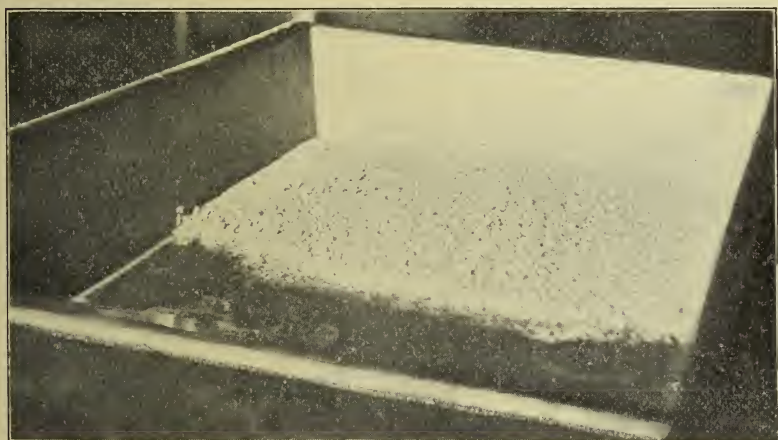
gassy. The B cheese was placed in an ordinary curing-room, and the percentage of gas-producing germs at the age of 10 days was .5. The cheese was examined at the end of 63 days, and was found to be slightly mottled, with fair flavor. The curd for the A cheese was divided into equal portions, one of which was placed in an ordinary curing-room at a temperature of 55 degrees to 60 degrees F., and the other put into the refrigerator curing-room, the average temperature of which was 40 degrees F. The percentage of gas-producing germs in both of these cheeses was very high. They were judged at the end of 63 days, when the taste and odor of both were found to be bad. The appearance of the one in the ordinary curing-room was very mottled. The one in the refrigerator curing-room was also mottled, but to a lesser extent.

These experiments show that gas-producing germs are able to produce a bad odor and flavor in cheese, and cause a mottled appearance, which is probably brought about by the bleaching action of the gases generated by the organisms introduced in the culture. The good effect of

a lactic acid starter when these injurious bacteria were present was very noticeable, and caused great improvement in the flavor and appearance of the cheese.



A piece of curd taken from a vat ripened with a starter containing gas-producing bacteria.



A floating curd caused by gas-producing bacteria.

BUTTER EXPERIMENTS. Pasteurized cream was inoculated with 5 per cent. of a gas-producing culture, ripened for 24 hours at 58 degrees, and then churned. The butter had a bitter, disagreeable, and slightly astringent flavor, and scored only 32 per cent. These experiments were subsequently repeated with other varieties of gas-producing bacteria, and with the same results, showing that these organisms were just as injurious to the flavor of the butter as they were to the flavor of cheese.

Ontario Agricultural College and Experimental Farm.

MACDONALD INSTITUTE.

OUTLINES OF NATURE STUDIES.

By William Lochhead, B.A., M.S., Professor of Biology and Geology.

TO THE TEACHER.

This Bulletin is published for you (not for the children), with the hope that it may help you in your own studies of Nature. It is not intended that you deal with all of the studies outlined in the bulletin, as the subjects are purposely given a wide range to meet the needs and aptitudes of teachers as a professional body. The questions are for *you* to answer as you investigate each problem presented. When you are familiar with the problem you will, if you are a good teacher, frame other and better questions for your pupils.

Nature-Study from your view-point as a teacher is *Natural Study*, a *method* or means of developing mental power in the pupil under the careful guidance of the teacher, by encouraging close observation of the things of Nature which lie about him, and by begetting an attitude of inquiry into their meaning so that the truth is discovered through the exercise of the pupil's own self-activities.

It is quite true that there are other values in Nature-Study, but they are secondary, viewed from a pedagogical standpoint. With many persons the acquisition of information about the things of Nature by a study of Nature is the chief aim; while with others the development of a sympathy with, and an interest in the common things that surround them, is the only value in its study. These secondary values are very great, but they can be realized as a matter of course by making method the chief aim of Nature-Study. Now we have Sympathy, Information, and Method, but the greatest of these is Method.

It is your duty, as a teacher, to develop this method of study among your scholars. You should know the mental characteristics of every child in your school, if you are to get the best results. You should also have a fair knowledge of the subject which you are asking the children to investigate, else your probing, sustaining, question, and your direction of the children's work will soon cease. The great needs of the teacher at the present juncture are *knowledge of the subject-matter*, and a *correct meaning of the Nature-Study Method*.

WHAT SUBJECT TO TAKE UP FIRST ?

Whatever has an interest for the children, whatever has an interest for you, or whatever is suggested by a reading lesson. Once you *begin* you will be surprised at the number of subjects which come up for investigation,—but *be sure to begin*.

HOW TO MAKE THE STUDY EFFECTIVE ?

1. Whenever possible, make it the basis for (a) *oral expression* (extempore addresses); (b) *written expression* (reports and composition); (c) *form expression* (drawing and modeling); (d) *color expression* (painting).
2. As far as possible correlate it with the other school studies, which will frequently be vitalised and refreshed by the correlation.
3. Encourage the making of collections of natural objects, and have school exhibitions at intervals.
4. Have boxes and cages for such live animals as toad, snake, rabbit, or crow, and flower-boxes for plants near the window.
5. Encourage the children to keep a diary of things seen outside of school, such as first flowers, first birds, first frost, first snow-fall, etc., etc. A school diary should also be kept, in which the children may make entries. (Nature-Study Journal).
6. Keep a school-garden. Get help if necessary from a neighbor, but keep a garden. By its means many problems can here be worked out in a concrete form. Have a school exhibit at the close of the season.
7. Give practice in *sight seeing*, or in reporting *Voyages of Discovery*.
8. Finally, try and read some of the most excellent books on Nature-Study which have been recently published. Get some of the best every year for your school library.

The new prescribed course in Nature-Study for Public Schools is quite explicit as to the scope of the work to be done in each form, but it must be noted that much latitude is given the teacher as to the subjects and mode of treatment. This is as it should be, for Nature-Study cannot be taught by a machine. It stands for independence and the full expression of the personality of the teacher. It stands also for the active pupil and the suggesting teacher.

OUTLINES OF NATURE STUDIES.

THE TERRARIUM.

A terrarium is easily made from an old berry crate or soap-box; it should contain three inches of good rich soil and the open sides covered with netting. Sod with lawn grass will do admirably. Other plants, such as thistles, clover, cabbage, etc., should also find a place in it. There should be a mossy corner where shy creatures may hide. The terrarium is of great value in Nature-Study for in it can be kept many creatures, such as caterpillars, crickets, grasshoppers and locusts, toads, and salamanders, and many others. It is then possible to study their habits at close range. The secret of making full use of a terrarium is to imitate nature, and to make the conditions for the encaged creatures as natural as possible.

THE AQUARIUM.

See O. A. C. Bulletin 134, "Hints on Making Nature Collections," page 7 on the making of an aquarium.

It requires a little experience and some experimenting to ascertain the right balance between the plants and animals of an aquarium. At the bottom there should be two or three inches of clean sand and a few stones. Only those animals and plants should be chosen which live in quiet water. When the balance is once established, but little attention is required beyond the addition of water. Every school should have an aquarium of some kind.

I. Plant Societies.

1. What is a plant society? Why do plants grow in societies?
2. What factors (ecological factors) determine the vegetation types by influencing their life and growth? What is a vegetation type? a flora?
3. Distinguish societies and colonies.
4. How do plants associate? Find examples.
5. Explain how societies may differ at different times of the year.
6. Name some common plant societies, and determine the main factor influencing the type.
7. Explain clearly; layers, zone, tension line, mesophyte, xerophyte, hydrophyte, and halophyte.

8. Discuss "Plant Migration" and "Distribution," the lines of stress, lines of migration, the causes of migration, the structural characters favoring migration.

9. Explain why autumnal coloration is so striking in American forests.

10. Determine the adaptations of the members of the different societies to their environment.

11. Make special studies of the plants of one or more of the following: (a) a swamp, (b) a pasture or meadow, (c) a roadside, (d) a thicket, (e) a woods, (f) a lawn, (g) a cliff, (h) a barnyard, (i) a sphagnum swamp or bog, (j) a pond, (k) rocks, (l) sand-dune, (m) a ravine, (n) a shore, (o) a dry hill-side.

Make (a) list of the species of plants growing in each society; (b) determine the relative abundance of each species; (c) locate the positions of each species, (d) and try to explain any adaptations.

12. Make diagrams of distribution of the plants in each area studied.

13. Observe and try to explain the adaptation in the following: (a) strengthening devices in the large leaves of milkweeds, basswood, and catalpa, (b) flat prostrate habit of many shrubs, (c) elastic stems of cereals, (d) hairy leaves of mullein, (e) colored buds, (f) underground fleshy roots and tubers, (g) "sleep" position of clover leaves, (h) rosette habit of dandelion, blueweed, and plantain, (i) thickened leaves of purslane.

14. Study the swamp-thicket society near your school.

[Consult Coulter and Atkinson.]

II. Flower Calendar.

Each student should keep a *Flower Calendar for Wild Flowers*.

Date.	Name of Flower.	Kind of Soil.	Shade or Sheltered.	Remarks.

The flowers are not to be picked, but rather studied in their wild haunts.

By examination of the earlier plants determine how they have developed so rapidly.

What advantage to the plant in developing so early?

Examine the roots of some of the early plants.

Compare the first pair of leaves produced with the later ones.

III. Some Spring Flowers.

SKUNK CABBAGE.

Note its habitat, and time of flowering, and answer the following questions :

1. Do leaves or flowers appear first ?
2. Make a drawing of the peculiar flower.
3. Do the stamens and pistils mature at the same time ?
4. What insects visit the flower ?
5. What kind of roots has it, and why can it appear so early ?
6. What is the nature of the mature fruit ?

JACK-IN-THE-PULPIT.

1. Compare Jack-in-the-Pulpit with Skunk Cabbage. Are these plants related ?
2. What insects visit Jack ? What is his habitat ?

HEPATIC.

Note :

1. Habitat.
2. Color—are all of same color ?
3. Fragrance.
4. Insects that visit the flowers.
5. Texture and color of leaves of fall and spring leaves.
6. Buds in the fall.

TRILLIUM.

Note carefully :

1. The habitat or home of the Trillium.
2. The species and their differences.
3. The underground portion.
4. The color, fragrance, and insects.

IV. Some Autumn Flowers.

BUTTER-AND-EGGS OR TOADFLAX.

Note where this plant grows and answer the following questions :

1. What insects visit the flowers ?
2. What attracts the insects ? Find where the attracting substance is kept. Is there any marking to guide the insect to the right place ?
3. Do the stamens and pistils mature at the same time ?
4. What is the nature of the root system, and why is this plant hard to eradicate ? Describe and draw the flower and fruit. To what family does it belong ?

SUNFLOWER.

1. Make a daily record of the changes in position of the head with reference to the sun. Do old plants change as readily as young plants ?

2. Is the plant affected by other conditions, such as cold, dew, rain, etc ?
3. Study the structure of the head, and locate the involucre, rays, and disk.
4. What difference between the ray and disk florets ? Draw one of each, and name the parts.
5. Do the stamens and pistils mature at the same time ?
6. What insects visit the flowers ?
7. Describe and draw the fruit.
8. To what family does the Sunflower belong ? Name other members.

GARDEN NASTURTIUM.

Examine flowers in all stages of maturity, and answer the following questions :

1. Describe the position of the stamens before the pollen is ripe ; when the pollen is ripe. Are all the stamens ripe at the same time ?
2. Describe the position and condition of the style with reference to the stamens at different degrees of ripeness.
3. What is the use of the spur ? Are there "guide lines" to the opening of the spur ? What is their position ?
4. Why does not the flower stand erect ?
5. Make drawings of the flower.

[Consult Newell's Outlines of Botany.]

V. The Dandelion.

1. Determine the arrangement of the LEAVES of the Dandelion ; what is the purpose of this arrangement ? Number and shape of the leaves ? Do you see any special adaptations ? What about the leaves of Dandelions growing in long grass ? Under boards ?
2. Where is the STEM of the Dandelion ? Determine its length and thickness. Account for the circular markings and scars on the stem. What special advantages in such a short stem ?
3. Describe the ROOT of a Dandelion which has been dug up and washed carefully. Account for the development of so many rootlets.
4. To what family of plants does the Dandelion belong ? Why ? Is the Dandelion a highly evolved plant compared with the Buttercup ? Why ?
5. Where are the flower-buds found ? Their covering and shape ? Have a cluster of Dandelions under observation for a week or more, and determine *when the buds open ; when they close ; how often a flower will open ; how long a period of sunlight is necessary to make them open.*
6. Study the opening of the *bracts* during the flowering period. Of what advantage to the plant is this opening and closing of the bracts ?

7. Determine the changes in the length of the **SCAPE**. What purpose is served? Describe the appearance of the flower when opened for the last time.

8. Determine if the stamens mature *before, at the same time, or later than* the stigmas. Make careful drawings of the flower.

9. Study the development of the **SEED**; describe the changes which take place. Draw a mature seed.

10. Place a long strip of the scape of a Dandelion in a saucer of water. What occurs? Account for the change. Take it out of the water and put it into a solution of salt. What occurs? Why?

[Consult Scott's Nature-Study and the Child.]

VI. The Leaf.

1. Observe the following details of the leaf as it grows on the plant in the field:

(a) The pattern and individual shape, (b) method of overshadowing and over-reaching other leaves, (c) adaptation for rain, (d) protection against wind, (e) mechanical support, (f) means of defence against insects and fungi, (g) arrangement for bud protection, (h) autumn coloration.

2. Note any adaptation for gathering the rain of: (a) Groundsel (directing water to base), (b) Common Lettuce, (c) Chickweed (line of hairs along the stem), (d) Ash, (e) Labiates, (f) Grasses.

3. Note any adaptation for protection against storms in the leaf of: (a) Ash (observe on a windy day), (b) Mountain Ash, (c) Beech, (d) Poplar.

4. Note any adaptation as to mechanical support in the leaf of: (a) White Catchfly, (b) Bracken, (c) Blackberry (examine cross-section of petiole).

5. Note any adaptation for bud protection in the bud of: (a) Horse-chestnut, (b) Rumex, (c) Wood-sorrel, (d) Verbascum, (e) Goose Grass, (f) Stachys, (g) Hawthorn, (h) Daisy.

6. Make a collection of leaves showing as many forms as possible. Try to identify the different maples and oaks by their leaves.

7. What is a leaf? What is its main function?

VII. Leaf Fall and Autumn Coloration.

1. Note the manner of leaf-fall upon as many shrubs and trees as possible, especially those with compound leaves.

2. Determine how long the leaves remain attached in privet, laurel, and the various evergreens.

3. Determine how the leaf separates from the stem. Section leaves attached to their stems early in autumn and observe the development of the "cleavage plate."

4. What is the economy of leaf-fall ?
5. Keep a record of the dates of (1) the beginning of coloring, (2) the color, and (3) the changes of color of leaves in autumn.
6. What is the probable influence of (1) frost, (2) oblique rays of sun, (3) diminishing water supply, (4) lower temperature, (5) declining activities of leaf, in autumn coloration. Discuss.
7. What new buds have been formed? How are they located with reference to the leaf? How many buds to a leaf?

VIII. Germinating Seeds.

1. Soak seeds of beans, peas, corn, squash, onion for a few hours in water.
2. Observe and draw external appearances, naming the various parts.
3. Compare structure of these seeds.
4. Germinate some of these in moist sand or loose soil, and examine every day for development. Make drawings to show the changes.
5. Determine how the young plants get out of the seed coat in each case.
6. What is the result if the seed is planted upside down?
7. Compare the habits and form of the Cotyledons of the different seeds.
8. As separate problems, determine the influence of warmth, moisture and air on germination, by suitable experiments.

IX. The Scarlet Runner Bean.

1. Compare with the Wild Cucumber and Pumpkin.
2. Germinate about 100 seeds.
3. Make drawings of the various stages in the germination of the seed. Compare the first pair of leaves produced with those that are produced afterwards. Draw them.
4. Its method of using the tendrils.
5. (a) Note the general shape of the tendrils.
 (b) Do they grow rapidly? Measure one and see.
 (c) Does the tendril always point in the same direction?
 (d) Note the direction it moves.
 (e) How far does it move, i.e., through how great an angle?
 (f) Does it always move in the same plane? or does it move up and down as well as from right to left?
 (g) Is there any advantage to the plant in having its tendrils move through an arc in this way?

(h) Hold your fingers so that it will touch a tendril for five minutes. What happens? Use a stick or lead pencil in the same way.

(i) When the finger or stick is removed does the tendril continue to curl up? Why?

(j) Does it ever straighten out again?

(k) Try one of the old tendrils. Cut it loose and see if it will uncurl again. Why will it not?

6. Nail a little stick just out of reach of one of the tendrils and watch what happens.

(a) Does the plant grow straight towards the stick?

(b) Does the plant act the same as if the stick were not there?

(c) Is there any attraction in the stick for the plant?
i.e., has the stick anything to do with making the plant twine around it?

(d) If there is no attraction between the stick and the plant, why is it the tendrils finally attach themselves to the stick?

X. Living Plants at Work.

The following simple experiments should be carried out whenever practicable, and their significance determined:

1. Place some soaked beans between two portions of damp carpet felt or thick blotting paper in a plate. Cover the whole with another plate placed upside down, and leave in a warm place. Examine every day, and observe any changes.

2. When some of the seeds have sprouted, mark off on the root and stem with India ink, commencing at the tip, very short equal spaces. Replace seedlings in the damp paper between the plates. Examine every day.

3. Grow some seedlings in the dark.

4. Tie carefully a piece of moist bladder membrane over the end of the bulb of a thistle tube, fill the bulb and part of the stem with a strong syrup of sugar, and place the whole bulb end down in a jar of water, taking care to have liquids at same level in stem and jar.

5. Scoop cavities in a carrot and sugar beet, dry carefully and fill with dry sugar. Set aside for a day or two.

6. Place thin slices of sugar beet in separate vessels of water and 10 per cent. solution of salt.

7. Place thin slices of red mangel, which have been boiled for a few minutes, in a dish of water.

8. Tie some rubber cloth or oiled paper about the pot in which geranium plant is growing and cover the whole with a glass or bell-jar.

9. Cut a shoot of geranium or begonia and place the cut end in a bottle of water colored with red ink. Leave for a few hours, and determine what parts of the stem are stained. Use a magnifying glass.

10. Place two small potted plants, one on each pan of a balance. Place a bell-jar over one of the plants. Counterpoise. Observe results.

11. After a few hours take off bell-jar, wipe the moisture carefully from inside and replace. Is balance restored? Explain.

12. Tear off a small strip of epidermis from the lower surface of a leaf, place in a glass slide, and examine with a microscope. Note the breathing pores, their shape and number.

13. Boil for a few minutes in water some green leaves; remove and immerse in alcohol until bleached. Notice color of solution. Place bleached leaves in tincture of iodine solution. What happens and what does it indicate? Try variegated leaves.

14. Test in the same way some leaves which have been kept in the dark for a few days.

15. Place some water-cress or other water plant in a jar of water and put in a sunny position. Contrive some way of collecting the gas and test it.

16. Place some soaked peas in a tall jar. Cover tightly with a piece of glass. Test the gas in the jar after 24 hours with a burning match. What is it?

17. Cover a potted plant with a bell-jar. Within place a beaker of clear lime-water and leave the whole in a dark room for a few days.

18. Place a potted plant or some seedlings near a window and leave for a few days without disturbing.

19. Observe the attitude of young sunflowers during a bright day.
(Consult Atkinson's First Studies of Plant Life).

XII. The Conifers.

1. What Conifers have their dry, thin bud-scales about the base of the leaves?

2. What Conifers have their needles single, but arranged on all sides of the stem? Arranged in two rows on the stem?

3. What Conifer has single, flattened leaves, inclined to turn upward so that the under side of the stem is nearly bare?

4. Determine how the cones of the different species stand; their size; their time of maturing; and when they cast their seeds.

5. Make short descriptions of the Conifers on the College Campus with regard to (1) *their leaves*; (2) *their cones*; (3) *their bark*; (4) *their habit of branching*.

6. Determine the position of the *fertile* and *sterile* flower clusters on the stems of (1) Larch; (2) Juniper; (3) Yew; (4) Arbor Vitae; (5) Pitch Pine; (6) White Pine; (7) Scotch Pine; (8) Austrian Pine; (9) Norway Spruce.

7. Study the young cones and draw them.
8. How can you tell the age of a Conifer? Ascertain how long the leaves remain attached to the twigs of the Conifer.

XIII. The Wood of Coniferous Trees.

1. In cross sections determine (1) whether the heart-wood and sap-wood are of the same color; (2) whether "autumn wood" is of the same color as the "spring wood."
2. Make diagrammatic sketches to illustrate.
3. Study the specimens in the laboratory.
4. Make a key for identification of different coniferous woods.
5. When are "spring wood" and "autumn wood" formed?

XIV. Logs, Lumber, and Knots.

1. Study the end of a large log of hard wood, and determine the areas: bark, wood, and pith. Make a drawing.
2. Where does a tree grow in thickness? Where is the oldest part of the wood?
3. What does each ring represent? Why? Why is the pith sometimes not exactly at the centre?
4. Of what is the bark mainly composed? How does the inside part differ from the outside? What is the use of the bark to the trees?
5. What is the meaning of the numerous fine rays (medullary rays) leading out from the pith? Are all of the same length? Do they extend into the bark?
6. Determine in which direction the wood splits most readily. Explain.
7. When a log is sawed into boards, will the "grain" of the boards differ according to the way the boards have been sawed? Show clearly by specimens and by drawings.
8. How is "quarter-sawed" lumber obtained? Why is it more expensive than other cuts? Why is it admired in furniture?
9. Examine a tree which has lost a branch (by accident or by pruning). What is happening to the cut end of the wound? Any diseased wood? Why does not the new wound-tissue (callus) always completely cover over the wound?
10. When lumber is sawed from a log made from a tree which has been deprived of branches at some stage of its existence, should you expect to find traces of such branches? What are they called in lumber? Explain the formation of "buried" knots.
11. Find out the various processes by which lumber is made up into furniture.

12. Where are the chief lumber regions of Canada? Why has the price of lumber advanced within recent years?

[Consult Percival and Bailey.]

XV. The Apple Twig.

1. Note the rings on main branches and twigs; cause? age of twig?
2. Examine branches of different ages, and compare the markings and buds.
3. From what buds are the longest growths? Why?
4. Observe the short branches with broken ends; what are these called? Why do not these bear fruit every year? What becomes of the buds formed on the spurs not bearing fruit? What is the cause of the broken ends?
5. Find out the following :
 - (1) Age of the twigs studied.
 - (2) Number of apples each fruit-spur bore.
 - (3) The fruit-spurs for next season.
 - (4) Where the blossoms did not set.
 - (5) Where the apples fell before maturity.
 - (6) Where terminal buds were injured, and lateral buds developed into fruit-buds.
 - (7) Any accidental markings.
 - (8) The dormant buds.

[Consult Bailey's Lessons with Plants.]

XVI. Spurs.

1. Examine and collect twigs of the various orchard and forest trees.
2. Determine the position of the fruit-spurs on the different twigs. Make careful drawings.
3. Write the story of each of the branches.
4. Some trees have few or no spurs and bear almost entirely on long shoots one year old; other trees produce their fruit-buds chiefly on the apex, or on the sides of spurs, the long shoots of the tree bearing only wood-buds the first year; while others bear almost equally on both long shoots and spurs.

Give examples of the three classes given above.

5. How do the red currant and gooseberry bear their fruit-spurs?
6. Determine if possible the age of fruit-spurs in the different trees studied.
7. What is the importance of a knowledge of fruit-spurs to the orchardist?

XVII. Trees.

1. Common Name, Scientific Name, and Family.

2. The tree from a distance in early spring or winter.

(a) The contour, habit of growth, or general outline of the tree, whether *pyramidal*, *spreading and rounded*, *pillar-like*, *symmetrical*, or *one-sided*.

(b) The color of the foliage.

3. The tree at close quarters.

(a) *Trunk*. Circularity, straight or crooked, or tapering, excurrent deliquescent, indications of disease or decay, size.

(b) *Bark*. Rugged or smooth; brown, gray, or silver white; any tendency to peel off in scales or come off; any lichens, moss or fungi.

(c) *Branches*. Whether inclined to the stem at an acute or obtuse angle; general difference between upper and lower branches; whether drooping, or have an upward trend or a downward curve; whether the twigs are one-sided, or on both sides of the main branch; whether alternate or opposite.

(d) *Twigs*. Whether crooked, rough-barked, indicating slow growth; or straight, smooth-barked, indicating quick growth; study of transverse section of twig, noting bark, wood and pith and annual rings and medullary rays; examine the buds, and note their relative positions, shape, color, scales, rudimentary leaves and flowers; relation of bud arrangement to branching, and the branching to the ultimate form of the tree; study of leaf-scars; study of bud-scale rings and age of the tree.

XVIII. The Woods of Dicotyledonous Trees.

1. The object of this study is the identification of the woods of our common trees. Transverse sections of twigs $\frac{1}{2}$ to $\frac{3}{8}$ inch or more should be made, and with the aid of a lens determine (1) whether there is any difference in density between the spring and the autumn woods; (2) whether the vessels are distinctly visible or hardly visible; (3) whether the medullary rays are wide and quite visible to the naked eye; (4) the color of the wood and medullary rays.

2. Make diagrammatic sketches to illustrate the difference between the various woods.

3. Study the specimens in the laboratory.

4. Try and make a key by means of which the woods can be identified.

XIX. The Development of the Apple and Cherry.

This involves a study of the ovary and its changes during the formation of the fruit. Sections of different specimens should be made at frequent intervals, and a series of drawings, kept with their accompanying dates.

1. Make longitudinal and transverse sections of the flowers of an apple. Observe the position and extent of the receptacle and the calyx-tube. Such observation should be made every two days.

2. Determine from your studies the formation of the apple,—the part occupied by the calyx, receptacle, and ovary-wall respectively.

3. Cut sections both longitudinal and transverse of the ovary of the cherry from the time the flower fades up to the time the fruit is quite large. Note especially the growth in thickness of the parts of pericarp, viz., the endocarp or “stone,” and the mesocarp or “flesh.”

XX. The Rose Family.

1. Collect, dry, and mount as many specimens of the Rose family as you can find.

2. Examine carefully the flowers of each, and make longitudinal, vertical sections of each.

3. Make careful drawings of the vertical sections,—the object being to determine the cohesion and adhesion of the parts of the flower.

4. Group all the forms studied into three: the *apple group*; the *strawberry group*; and the *plum group*.

5. Try to determine the relationships of the forms studied.

6. Compare a raspberry with that of a strawberry. Watch their growth after the flower fades.

7. Watch the development of the ovary of a plum when the flower begins to fade. What becomes of the receptacle?

The following forms at least should be studied: apple, plum, strawberry, spiraea, cherry, june-berry, raspberry, wild rose, hawthorn, pear, cinquefoil, barren strawberry, blackberry, mountain ash.

XXI. The Legumes.

Some Special Studies (Spalding):

(a) Arrangements for cross-fertilization.

(b) Extent to which the production of seeds of RED CLOVER is dependent on the agency of insects.

(c) Capacity of the COMMON PEA for self-fertilization.

(d) Occurrence of modified leaves, such as tendrils.

(e) Morphology of protective structures of various leguminous plants, e.g., spines of locust and honey locust, hairs of desmodium, etc.

(f) Sleep movements of Clover, etc.

(g) Causes of the wide distribution of the family.

1. Classify the legumes of the farm according to their leaves, noting whether the leaves are (1) PINNATE, ending in tendrils; or (2) PINNATE with two or more pairs of opposite and one single terminal leaflet; or

(3) leaves with three leaflets; or (4) leaves DIGITATE with more than three leaflets.

2. Study the legumes of a farm. Make a list of the forms.

3. Collect and study the various CLOVERS to be found in the Experimental grounds. In what respect does the young seedling Red Clover differ when grown with cereal crops than when grown alone? Is alsike a hybrid, as its scientific name would imply, (*Trifolium hybridum*)?

4. Watch carefully the flowers of *white clover* (*Trifolium repens*), and determine how such flowers are fertilized; what occurs to each flower after fertilization; how the unfertilized ones (old maids) can be told?

5. Which species of clovers are *annuals*, *biennials*, *perennials*? Which are upright growers and which are creeping?

6. Compare the *Medicagos* with the Clovers. Is Black Medick a weed?

7. Compare the *Melilots* with the Clovers. Is White Melilot a weed?

8. Contrast the *Peas* and the *Vetches*. Compare their flowers, and note any points of difference between them. What difference in germination? Make drawings.

9. Collect and preserve the tubercles of the various legumes.

XXII. Grass Investigations.

1. Collect samples and bundles of the various wild and cultivated GRASSES.

2. Determine the following regarding each GRASS:

(a) The time of Flowering.

(b) The height of growth.

(c) How it withstands drouth.

(d) How it withstands excess of water.

(e) How it withstands pasturing.

(f) Its palatability.

(g) Its roots, habits, whether creeping, or tufted.

(h) Its duration, whether annual, biennial, or perennial.

3. Make germination experiments of as many grasses as possible, and study the habits of the seedlings.

4. Collect samples of commercial grass-seed from various seed houses, and determine the *purity and vitality*.

XXIII. Recognition of Grasses by their Leaves.

1. Ascertain how the leaves are folded in the bud, whether (a) simply folded, or (b) rolled. *Poa pratensis* (June Grass) is folded, and *Phleum pratense* (Timothy) is rolled.

2. Ascertain if there are clasping claw-like appendages at the base of the leaf. *Lolium perenne* (Perennial Rye Grass) and *Festuca pratensis* (Meadow Fescue) have such claw-like appendages, while Fox-tail has none.

3. Ascertain the color of the leaf sheaf below ground.

4. Ascertain whether the leaves are cylindrical or flat; narrow or broad, prominently ribbed or not; the color of the veins.

5. Ascertain whether the leaf-sheaths are smooth or hairy; keeled or not.

6. How do fruit-growers control the Codling Worm?

7. Describe and draw a "scabby" apple. What are the objections

8. Make a *key* by means of the characters of the leaves.

XXIV. The Apple as a Host.

Secure specimens of "wormy" and "scabby" apples.

1. How many kinds of apples do you know?

2. Is there a difference in the size of the cores of different apples?

3. Cut crosswise and lengthwise of two apples. Answer the following questions and draw:

(a) How many cells in the core? How many seeds in each cell?

(b) How do the seeds point? Are they attached?

(c) Is the blossom end connected in any way with the core?

(d) From what part of the flower has the apple (fruit) been derived.

4. Write out an account of the work of the Codling Worm. How many broods in a season? How does it spend the winter? Collect the different stages of this insect.

5. Where did the worm leave the apple?

6. How do fruit-growers control the Codling Worm?

7. Describe and draw a "scabby" apple. What are the objections to scabby apples? Determine how and where infection takes place, and the development of the disease.

8. How do fruit-growers control the "scab"?

9. Make a collection of other enemies of the apple.

XXV. Fruits.

Collect for comparison and study the fruits of most of the common plants in the vicinity.

1. Group them into (1) *dry*, and (2) *fleshy* forms.

2. Group all the dry fruits into (1) *Dehiscent*, and (2) *Indehiscent* forms.

3. What is the general name for a dehiscent fruit? What is the pericarp?

4. Group the dehiscent forms into (1) those derived from a simple one-celled ovary, and (2) those derived from a compound several-celled ovary.

5. Examine the indehiscent fruits; determine how they have developed from the ovary, and make out the changes that have taken place while maturing.

6. Group the fleshy fruits into (1) berries, drupes, pomes, hips, haws, and pepos.

7. Study the fruits of the evergreens; compare them.

8. Study the fruits of the ferns, club-mosses, and mosses.

9. Account for the brilliant colors of some of the fruits.

10. Why is unripe fruit usually green?

11. Why are the seeds of many fruits unpleasant to the taste?

12. Why have some fruits a hard coat next the seed?

13. Why are the seeds of some fruits very small?

14. Why are the edible portions of nuts protected by a shell, and unprotected in berries and such fruits?

XXVI. Nuts.

Collect specimens of hazelnuts, beech nuts, chestnuts, hickory nuts, walnuts, and butternuts.

1. Are all of these fruits? Why? Are they dehiscent or indehiscent? Why?

2. In the case of the first three, of what is the "bur" composed? Does it dehisce in all three?

3. In the case of the last three, of what is the "shuck" or "hull" composed? Does it dehisce in all three?

4. How many cells and seeds does each nut contain? In the chestnut, for example, there are sometimes two kernels in a nut. Explain.

5. What change has taken place in the wall of the ovary of each nut in the process of ripening?

6. Give a botanical definition of *nut*. Is the acorn a nut? Is the horse-chestnut a nut?

7. Why are nuts usually dull colored?

8. Why is the edible portion of nuts protected by a shell?

9. How are the nuts distinguished?

10. How are unripe nuts protected while on the tree?

11. Study the common commercial nuts, such as are sold on the market.

XXVII. Dissemination of Seeds.

Make a collection of seeds, and examine carefully. Answer the following questions:

1. Why do so many seeds have special growths attached to them?
2. Arrange and name the seeds collected according to whether they have

- (a) Barbs or grappling devices.
- (b) Provision for floating on water.
- (c) Provision for floating in the air.
- (d) Mechanism for ejection.
- (e) Juicy parts attractive to animals.

3. Observe carefully and record the special adaptations to distribution possessed by: Witch-hazel, touch-me-not, dandelion, burdock, beggar-ticks, blueweed, white pig-weed, cherry, basswood, sedge, pine, milk-weed, maple, poison ivy.

4. Why are the seeds of most weeds dull colored?
5. What are the main methods of dissemination of weed seeds?
6. What birds are largely instrumental in dissemination of seeds?

[Consult Beal's Seed Dispersal.]

XXVIII. Domestic Animals.

1. Compare the dog, cat, cow, horse, and sheep as to (a) habits of feeding, (b) coverings, (c) shape of limbs, (d) mode of using the limbs, (e) their paws or hoofs, &c., (g) teeth, (h) shape of head.

2. What animal was probably first domesticated or tamed?

3. Study carefully the dog: Kinds—shepherd dog, coach dog, hunter, &c.; as companion or playmate; care of dogs, intelligence, and fidelity; strong senses of hearing and smelling; character of paws and claws; what wild animals are related to the dog?

4. Study the *cat*, comparing it with the dog as to intelligence, form, use, manner of walking, senses, affection, paws, and claws, tongue, bad habits. What wild animals are related to the cat?

5. Study the *cow*: What kind of food does it eat? How does it eat? What is the "cud"? What are *ruminants*? Name some ruminants. Of what use are the horns? What are some of the uses of the living cow? Of the dead cow? How does the cow lie down? Get up?

6. Study the *horse*: Importance in commerce and war; to civilization; kinds; intelligence; dentition; kind of food, manner of eating; feet, the way the horse lies down and gets up; care of horses; origin; wild horses. What wild animals are closely related to the horse?

XXIX. Animal Movements.

1. Study the way the following animals walk: Horse, cow, cat, dog. In what order are the feet placed in walking? In trotting? In galloping?
2. Study the movements of an earthworm, a clam, an insect.
3. Study the movements of a fish, a snake, and a bird.
4. How does a rabbit run? A robin or a crow walk?
5. To what extent has the need for getting food affected the manner of movement of animals? Study cat and dog.
6. To what extent has the place where food is obtained affected the movement? Study fish, bird, earthworm, clam.
7. To what extent has the need for escape from enemies affected the mode of movement? Study rabbit, squirrel.

XXX. Animal Coverings.

1. Compare the natural coverings of man, horse, cow, rabbit, cat, pig, sheep, mink, hen, turtle, snake, frog, fish, caterpillar, and earthworm. Name those covered with hair, with fur, with wool, with feathers, with scales.
2. What is the use of the covering? Does it vary from season to season in different animals?
3. What is the difference between fur, hair, and wool?
4. Where do fur-bearing animals live? Where animals with hair?
5. What is the arrangement of the feathers on a bird? What is the special advantage of feathers as a covering?
6. Compare the winter plumage with the summer plumage of birds.
7. How are the scales of a fish or snake arranged? Of what advantage?
8. What is peculiar about the coverings of insects? How can insects grow with such coverings?
9. Why does a snake shed its skin? How often?
10. To what uses are the coverings of animals put? Specify.

XXXI. Food-Getting Among Animals.

1. Study the ways the horse, cow, sheep, cat, and dog seize their food.
2. What animals use their fore limbs in eating? What do not?
3. What animals are flesh-eaters? What are plant-eaters?
4. Study the dentition of rabbit, cow, horse, sheep, and man. What are the names of the different kinds of teeth and the use of each?

5. Study carefully how the cat eats its food. What other animals eat their food in the same way? Of what use is the tongue?

6. How does the dog and cat take liquid food?

7. What animals get their food at night?

8. What is the food of the earthworm and how does it take it into its body?

9. Watch how a snake takes its food, a frog, a caterpillar.

10. To what extent do the kind of food and the food-getting affect the shape of the head and jaws?

11. Does the food supply affect the habits of animals at different seasons?

12. Determine whether the following animals are beneficial or injurious: Mole, snake, toad, sparrows, hawks, owls, woodchucks, squirrel, weasel, racoon, rat, mouse, plant-lice.

XXXII. Adaptations Among Animals and Plants.

1. In what particular is the *cat* adapted for (a) securing food, (b) protecting itself, (c) defending its young, (d) in fighting with another cat or other animals, (e) its surroundings?

2. Study the adaptation of the squirrel, the hawk, the horse, the giraffe, the deer, the mole, to their respective mode of life.

3. Find examples of caterpillars and other insects which are protected by their color. What higher animals are protected in this way?

4. How are the skunk, the porcupine, the wasp, and the bee protected?

5. To what extent are fishes, birds, reptiles, and worms adapted to their mode of life?

6. Find plants that are well adapted to their particular mode of life.

7. What are some of the means plants have of surviving under unfavorable conditions?

8. Explain how all plants and animals are adapted to their surroundings?

(Read "Animal Life" by Jordan and Kellogg: Appleton).

XXXIII. Snails and Slugs.

These animals belong to the sub-kingdom Mollusca, (mollis, soft; esca, flesh). Why?

Slugs have an internal flat shell, while snails have one coiled internal valve.

1. *The Shell.* Find all the different kinds of snails you can. Rest the shell on its base with the aperture pointing toward you, and draw a plan of the spiral. Does the spiral run to the right or to the left? In a

right handed dextral shell, *Helix*, *Limnaea*, in this position the aperture is to the right of the axis. Or imagine such a shell a spiral stair-case, as you ascend, the axis of the spire will always be on your left. Can you find any left-handed (sinistral) shells? (*Physa*). All whorls nearly in the same plane, (*Planorbis*). How many whorls are there in the spiral? (The largest is the body-whorl, where most of the soft body of the snail is protected, the rest is the spire.)

Observe the lines of growth running parallel with the opening in the shell. Note the color and surface markings. Can you see a few well-marked lines often separating off areas of different depths of color? These each distinguish one year's growth from another. How old are your specimens?

Break out a piece of the shell from the edge of the body whorl. Is the gap filled in, or is the new piece of the same color as the rest of the shell? Try the same experiment again removing parts of shell from the body-whorl, not from the edge but from the spire. How long does reparation require? Is there any protective coloration?

2. *Locomotion*. Snails and slugs belong to the class *Gastropoda* (bellyfooted) as foot is on the ventral surface of the body. Let snail crawl on a piece of glass, and watch its movements from the under side with a lens. Do you see a wavelike motion? Which way do the waves move? Why can snail hold on to a surface so firmly?

3. *Head*. How many horns on the head? Describe them. Where are the eyes. Are some of the tentacles more sensitive to touch than others? Watch mouth and its motions. Observe how it feeds. Can you see tongue (radula) as a *Helix* rasps off the epidermis of a leaf? (The radula ribbon is covered with thousands of minute sharp teeth).

4. *Respiration*. Observe the opening to the lung on the right side of the body. What movements of the aperture occur? Will *Helix* live in water? Will *Limnaea* live long totally submerged, and completely deprived of air?

5. *Food*. Try feeding experiments with *Helix*, *Limax*, and *Limnaea*. Try leaves, dry leaves, soap, dead bodies of snails and slugs, and other species; lichens, mayflies, coleoptera; raw beef, fungi. Will *Limax* bite your hand? Try tender skin between fingers.

6. *Regeneration*. Do lost tentacles, eyes, parts of the foot grow out again if cut off?

XXXIV. The Sundew.

1. Observe the habitat and general habit of the sundew.

2. Draw a leaf, showing the tentacles.

3. Grow sundew in shallow wooden dishes containing peat, and kept in a room at a temperature of 70 degrees F.

4. "Place pieces of rotten wood, boiled meat, or boiled egg, or bits of glass no longer than a pin head, on the tips of the glands of the tentacles at the margin of the leaves," and watch the result.

5. How long before movement takes place ? Use a lens.
6. Does relaxation of the movement occur while the object remains on the tentacle ?
7. Do all the objects mentioned secure equal reactions ?
8. How is the amount of secretion influenced by the different objects ?
9. Place a small cube of 1 mm side, with sharply cut edges, of the white of a hard boiled egg on each of several sundew leaves, and determine if the albumen is digested after a day or two.
10. Determine the structure of a tentacle, using a microscope. Observe the spirally thickened wood-fibres, or "water-pipes."
11. Try the action of very dilute solutions of ammonium salts on the bending of the tentacles.
12. Try the action of sugar, starch, dilute alcohol, milk, mucous, and saliva.
13. Are the stalks of the tentacles sensitive ?
14. Repeat Francis Darwin's experiments as to the effect of feeding sundew with roast meat (1-50 grain) on the nutrition and reproduction of the plant.

XXXV. The Wheat Rust.

1. Collect specimens of diseased barberry leaves, and determine when the cluster-cups are mature.
2. Make careful drawings of the cluster-cup.
3. From the mature cluster-cup remove some spores to a moistened leaf seedling of wheat or oat plants.
4. Determine when the rust appears on the wheat or oat leaves after inoculation.
5. Inoculate other wheat plants and other oat plants from the first inoculated plants.
6. Try to get specimens of wheat or oats infested with Black Rust, and which have wintered over in exposed places. Determine how the Black Rust spores germinate.

XXXVI. The Life History of the Toad or Frog.

1. Collect the eggs at the river in early spring. About how many eggs are laid by one toad ? What is the difference between the toad's eggs and the frog's eggs ? Keep the eggs in a flat glass dish in water and watch them hatch. Change the water every two or three days. Draw a few eggs.
2. Draw the tadpole in its various stages of development. Note some of the habits of the tadpole, how it swims, breathes, etc.

3. Test them with various kinds of food.
4. Note the development of the legs.
5. What becomes of the tail ?
6. Examine its eyes. Has it any eye-lids ?
7. Study the habits of the frog.
8. What does it eat ?
9. How does it breathe ?
10. Does it ever drink ?
11. Experiment. Deprive a toad of water for a day and weigh him carefully. Next sit him on a wet blotting paper for an hour or two and weigh again. What is the increase in weight due to ?
12. Note its humpbacked body and its sitting posture.
13. What are the natural enemies of tadpoles ?
14. What are the natural enemies of the frog ?
15. Since so many eggs are laid by each female frog, and nearly all these produce tadpoles, how do you account for so few frogs ?
16. Of what economic value are toads ?
17. Write a short account of the life history of the toad, and compare with that of the frog.
18. How many kinds of frogs in your vicinity ?

XXXVII. Mosquitoes.

1. Collect some larvae of mosquitoes in stagnant water, and place them in a glass jar for observation.
2. Watch carefully the habits of the larvae,—how they breathe, how they swim, and whether heavier or lighter than water.
3. Make drawings of the larvae.
4. How long do the mosquitoes remain in the larval stage ?
5. Study carefully the pupa stage,—how it differs from the larval, how it breathes, etc.
6. Watch the escape of the adult mosquito. Describe the operation. What state of water is necessary ?
7. Are all the larvae exactly like ? the pupae ? the adults ? What difference between the male and female ?
8. Secure specimens of *Culex*, of *Anopheles*, both males and females.
9. Try simple experiments on the killing of the larvae with oil.
10. Endeavor to get the eggs of mosquitoes. Draw the egg mass.
11. Ascertain the exact duration of the different stages of the mosquito.

XXXVIII. Some Underground Growths.

Collect typical samples of potato tuber, carrot, turnip, and mangel or beet,—

1. Examine the arrangement of the “eyes” on a large potato tuber, and note where they are most numerous.

2. Cut longitudinal and cross sections passing through an “eye.” Make drawing, and determine the nature of an “eye.” How many buds in an “eye”?

3. What reasons have you for supposing the tuber to be a modified stem? Illustrate by drawings. Locate the cortex, epidermis (periderm), vascular cylinder, cambium ring, and pith. Where is the wood?

4. What is the chief reserve food stored in the tuber? How would you test its presence?

5. Do the true roots rise above or below the tuber-bearing branches in field?

6. What is the advantage of exposing the tubers for planting to light for a week or more?

7. What is generally the shape of the carrot? How are the small secondary roots arranged?

8. Make longitudinal and cross sections of a carrot? Note color, thickness, and texture of the various parts. Draw.

9. Has a carrot a root or a stem structure? Where is the base and the cortex? the wood? the cambium-ring?

10. What is the difference between (1) the root of cultivated and wild forms of carrot, and (2) the first and second year's growth?

11. Make longitudinal and transverse sections of a turnip. Draw. Note color, thickness, and texture of the various parts.

12. Locate bast, cambium and wood. Of what is the wood composed?

13. Make longitudinal and transverse sections of a mangel or beet. Draw; note color, thickness, and texture of the various tissues and soft parenchyma. Which parts are colored? Name the parts as seen in sections.

[Consult Percival's Agricultural Botany.]

XXXIX. Spiders.

Field excursions should be made for the study of the work and habits of spiders. A few spiders may be brought into the class-room and placed in the terrarium, where their habits can often be readily observed.

1. Find *orb-webs*, *funnel-webs*, *cob-webs*, and the threads of the *balloon spiders*. Make drawings of the structure of each web, and note where each web is found.

2. Where does the funnel-web spider lie in wait for his prey ? What is the appearance of this spider, and what is the structure of the web ? Observe and describe the tunnel.

3. How does the orb-web spider or weaver make his web ? How many kinds of silk are used ? How is the spiral thread arranged ? Where does the spider lie in wait for its prey ? How does the spider pass from one side of the web to the other ?

4. What is the structure of a *cob-web* ?

Where and how does the spider lie in wait ?

5. Find, and study *jumping spiders*, *running spiders*, *ballooning spiders* ; harvestmen.

6. Observe how the silk is spun by the spiders.

7. Collect the egg-sacs of spiders, and note where they are found. Determine when the eggs hatch.

8. Compare a spider with an insect. In what respect do they differ ?

[Consult Comstock.]

XL. Plant Galls.

Collect the Galls on as many different plants as possible, and make drawings of their shape and contents.

Try and answer the following questions :

1. What galls have openings ?

2. What galls are single-celled ? Many-celled ?

3. What galls become empty before the close of autumn ?

4. Find examples of galls on roots and stems.

5. Study carefully the Pine-Cone Willow-Gall, and give a reason for the Cone. Keep some of these Willow-Galls in a jar, covered with cheese cloth, until spring.

6. Put away also some of the Mossy Rose-Galls and Oak-Galls.

7. Classify the galls collected according to the insects producing them. Which were made by aphids ? by Hymenoptera (Cynipids) ? by Diptera (Cecidomyia) ? by moths ? by mites ?

8. How were the galls made ?

9. Compare the galls found on Golden Rod ; on Oak ; on Maple ; on Elm ; on Grape ; on Witch-hazel ; on Poplar ; on Hickory ; on Rosa ; on Rubus.

XLI. Earthworms.

1. Prepare a wooden box with holes on side to admit air ; almost fill the box with rich, moist earth, in which are many decaying leaves and stems ; place some earthworms on the surface ; moisten the earth occasionally.

2. Observe the habits of the worms in the box, how they bore through the earth; why they come to the surface after rain.

3. Examine worm-casts,—their shape, whence they came, and how they are brought to the surface.

4. Determine how a worm crawls,—

5. Examine the front end; does the worm always travel the same end foremost?

6. Examine the home of the earthworm, using a trowel to remove the layers of earth; what is found in the holes?

7. Find out the kind of food the worm likes; try different kinds.

8. Are roots of plants eaten by earthworms? Where are worms most abundant?

9. Determine the sense-organs of earthworms:

(a) Note the quickness with which they retreat when disturbed by a heavy step on the earth near their burrows. What sense has warned them of the approach of danger: seeing, hearing, or feeling?

(b) Note the force with which they cling to their burrows when an attempt is made to drag them out.

How is it they cling so strongly?

Examine the sides and under surface of the worm for an additional cause.

(c) Can they see? Test by bringing light towards them.

(d) Can they hear? Test by yelling close to one or beating a tin pan.

(e) Can they smell? Test by hiding a piece of its favorite food which you have already determined by experiment, and note whether it finds it.

10. Determine the general appearance of an earthworm.

11. Find the eggs of earthworms; the sac which contains them.

Watch a rich piece of lawn well, before dusk, and, with lantern in hand, watch carefully the habits of the worms which come to the surface after dark.

XLII. The Songs of Insects.

Collect some crickets, locusts, katydids, meadow grasshoppers, and tree crickets, and place them in a terrarium in which there is some green grass.

1. Determine if both males and females sing.

2. Observe carefully, and determine how each singer makes noise.

3. Find where the "ears" are situated.

4. Try and procure a Cicada, and determine how it makes its peculiar song. Is the singer male or female?

5. What other insects make noises?

XLIII. An Ant's Nest.

Prepare an ant's nest (see Comstock's Insect Life, p. 279).

1. Are all ants' nests alike? In what situations have you found them?
2. Describe a nest.
3. Describe the appearance of the different kinds of ants in a nest. What is the duty of each kind?
4. What are the white bodies seen in the nest?
5. When have you seen winged ants? Try and find an ant ridding itself of its wings.
6. Make a collection of all kinds of ants you have seen.
7. What relationship have you noticed between ants and aphids?
8. What is the best way of ridding a room of ants?

XLIV. The House-Fly.

1. Why are house-flies more abundant in September than in early summer?
2. Watch a fly feed. How does it take its food? As a solid or a liquid? Does it make use of its feet while feeding? How?
3. Determine the structure of its mouth. By pinching a fly's head gently the mouth parts will protrude. Examine with a lens. Draw.
4. Draw the house-fly while it is resting on a piece of paper. Name the parts.
5. Where do house-flies deposit their eggs? Observe the creatures that hatch from the eggs. What are they called? Find the next stage. Preserve these in a box. What are these called?
6. Catch some of the flies that bite before rain. Are these house-flies? Examine carefully, and look at mouth parts.
7. Examine a fly's foot and try to account for its clinging to ceiling.
8. Collect other flies that frequent the house and determine the difference between them and the house-fly.

XLV. The Currant Saw-Fly.

1. Collect, draw and examine the leaves of the currant on which are deposited the eggs of saw-fly.
2. Note the location of the eggs on the leaves.
3. Collect some of the adult insects and pin them in your collection.
4. Determine the duration of (1) egg stage, (2) larval stage, (3) pupal stage.
5. Describe the mode of feeding of the larvae.

XLVI. The Pear Tree Slug.

1. Find some of the eggs, and if possible some of the females ovipositing. What is the shape of the egg?
2. How many eggs to a leaf?
3. Examine larva and its manner of feeding.
4. Its duration as larva. Number of moults.

XLVII. The Spruce Gall-Louse.

1. Examine carefully some infested twigs of white spruce, and determine the shape of galls.
2. Watch for the deposition of eggs in woolly coverings about May 10th.
3. Draw egg masses. Estimate the number of eggs.
4. How long before the eggs hatch?
5. Watch the grey lice for five or six successive days, and determine how the galls are made.
6. What are the best means of combating the gall-lice?

XLVIII. The Oyster-Shell Scale.

1. Collect specimens of twigs infested with Oyster-Shell scale, and determine what stage of its history the insect is passing through.
2. Make careful drawings of the adult and young of this insect.
3. Try to find out how far the young would move from the mother scale before it settles down—about June 1st.
3. Determine if you can the duration of each moult.

XLIX. The Larch Saw-Fly.

1. Search carefully in the soil in the larch grove for dark-brown oval objects, and take them to your room; place them in a box and await developments.
2. Describe carefully the adult saw-flies. Any difference between sexes? Pin several for your collection.
3. Observe the females depositing their eggs. Describe the process. How many eggs in the group? Make a drawing of the eggs in place on the twigs. Account for the bending of the twigs.
4. Determine the duration of the egg stage, the number of moults of the larva, the duration of each moulted stage, and any differences between the different moults. Collect specimens of the different moults for your collection.

L. The Potato Beetle.

1. How does the insect pass the winter? When did you first see the adult?
2. Determine the date of the first appearance of eggs. How many in a cluster? How long to lay the eggs? How long in the egg state before hatching? Color? Collect. Where are the eggs laid?
3. Observe the larva in its different moults, and the duration of each moult. Collect the pupae.
4. Describe the full life-history.

LI. Lady-Bird Beetles.

1. Collect as many kinds of Lady-Birds as you can, taking notes of what they were doing when you collected them.
2. What other insects did you find on the same plant?
3. Collect as many Lady-Bird larvae as you can, and preserve them in vials for reference and study.
4. Identify the Lady-Birds collected by means of Comstock's Manual and other reference works.
5. How are Lady-Birds distinguished from leaf-eaters (Chrysomelids)?
6. Determine where the pupa is formed and how.
7. Of what advantage to the Lady-Birds are their bright colors?
8. Make drawings of the most commonly occurring lady-beetles, showing the variations and marking.
9. What Lady-Birds do you find in the greenhouse in scale-infested plants, or on apple trees infested with Oyster-Shell Bark Lice?
10. What Lady-Birds do you find on trees infested with *aphis*?

LII. Some Common Autumn Insects.

Make a collection of as many members of Orthoptera as possible; classify, and name them.

2. Observe the habits of *cockroaches*, *long-horned grasshoppers*, *short-horned grasshoppers*, and *crickets*.
3. Determine where they spend the winter.
4. Describe how the grasshoppers and crickets deposit their eggs.
5. Collect "woolly bears," milkweed caterpillars, dagger caterpillars, tiger caterpillars, fall web-worms, and cabbage worms. Place them in separate boxes and feed them their appropriate leaf-food. Watch carefully from day to day for developments.

LIII. Birds.

In the study of birds the student should determine the following points :

(a) size, (b) color, (c) markings, (d) shape of body, bill, wing, tail and foot, (e) appearance, (f) movements, (g) flight, (h) localities frequented, (i) food, (j) song, (k) habits, (l) nest, (size, form, material building), (m) eggs, (n) incubation, (o) young. Record in a note-book.

1. Keep a bird Calendar, such as the following :

Name of Bird.	When First Seen ?	How many were seen ?	When it was next seen ?	When did it become common ?	When it was last seen ?	Is it common or rare ?	Does it breed near station ?	Remarks.

2. Make a list of birds which pass during the Fall Migration.

3. Study carefully the *English Sparrow*.

(a) Describe the appearance. Compare the male and the female.

(b) Where do sparrows build their nests? Color of eggs?

(c) Do you find as many sparrows in the country as in the city?

(d) Notice the food habits of sparrows during each of the fall and winter months. What seeds have you seen them eat?

(e) Where do sparrows roost? How many in one place at one time?

(f) Does the English Sparrow molest any other bird?

(g) Is it a friend or a foe?

4. Study carefully the *Common Crow*.

(a) Describe the appearance, size, etc.

(b) Watch a crow flying. Note the peculiarities of flight.

(c) Do crows winter in this district? Find the "crow dormitory," if any.

(d) Notice the food habits of crows. What food have you seen crows eating?

(e) Describe a crow's nest, and the eggs and nestlings.

(f) Compare plumage of young and old crows. Do males and females differ in color?

(g) Discuss the intelligence of the crow. Give evidence.

(h) Is the crow a friend or a foe?

5. Study carefully the *Woodpeckers*.

(a) How many species have you seen? Name them.

(b) Describe the appearance of each.

(c) Note the holes made by the *Supsucker*. How are they arranged? What is the object of the holes? Is it a friend or a foe?

(d) Watch the *Red-headed Woodpecker*; what is the nature of its food?

(e) Describe and draw the Red-headed Woodpecker.

(f) Compare the *Downy* and *Hairy Woodpeckers*. What is the nature of their food? Are they friends or foes?

(g) How do Woodpeckers *drum*? What is the difference between the *tap* and the *drum*?

(h) How does the woodpecker use its tail in climbing? What is the arrangement of its toes?

(i) Describe the *Flicker*. Compare it with the other woodpeckers.

(j) Compare the male and female flickers and other woodpeckers as to color and markings.

(k) Watch a flicker feeding its young.

(l) What woodpeckers are winter birds? Find out when the others come and go.

LIV. The Robin.

1. *Movements*. Describe the movement of the robin on the ground; and its manner of flight. Compare its flight with that of the Swallow, Song Sparrow, Meadow Lark, Red-headed Woodpecker. What are the characteristic movements of the Robin?

2. *Song and Call*. How many different calls can you detect? Imitate them. What is the apparent meaning of each call? At what seasons does the Robin sing? Does it sing at night? When raining?

3. *Color and Shape*. Are the males and females of the same color and size? Are the young of the same color as the old? What parts are dark? Pure black? White? Red? When does the Robin moult? Draw the robin.

4. *Nest and Eggs*. Determine the time occupied in building the nest and in brooding. When does it begin to make a nest? Where does it build? Of what is the nest built? Is the nest used more than once? How often each season does the Robin brood? How long before the first egg is hatched? What is the number, shape, and color of the eggs? When does the mother bird leave the nest to feed?

5. *Food*. What is the most common food of the Robin? When is the Robin not beneficial? What is the food of the young? Compare the food of the Robin with that of the Bluebird, Wood Thrush, Hairy Woodpecker, etc.

6. *General Questions*. Where do the Robins pass the winter? What is the exact date of leaving your locality? And return? Do the same Robins return every spring to the same localities? Compare the nesting habits of the Robin with those of the other members of the

Thrush family. Do both males and females look after the nest and help to feed the young?

LV. Bird Identification Blank.

Locality
 Date
 Haunt
 Length (tip of bill to end of tail)
 Size and shape of bill
 Length and shape of tail

COLOR—

Forehead
 Crown
 Cheeks
 Nape
 Back
 Rump
 Upper-tail coverts
 Tail.....
 Wings
 Throat
 Breast
 Abdomen
 Voice
 Movements
 Nest
 Food

Then use the *keys* in Merriam, Hoffman & Walter for identification.

LVI. Red Squirrels.

1. Why are red squirrels not desirable animals to have about home?
2. Find a nest. Has it the same nest for both summer and winter?
Of what is it composed?
3. What is the food of red squirrels? Watch a squirrel eating.
Sketch.
4. Show clearly how the squirrel is well adapted to a life among trees.
5. Examine the mouth of a squirrel, and show how the teeth are well adapted for opening nuts and grinding hard seeds.
6. What enemies have squirrels? Watch a squirrel in flight. Determine how it passes from tree to tree.
7. Study the calls of the squirrel.
8. What are the uses of the tail?

9. How does the chipmunk differ in appearance from the red squirrel ? Sketch.
10. Compare the habits of the squirrels.

LVII. Water, Steam, and Ice.

1. Determine the physical properties of water, such as color, taste, shape, surface, and cohesion, by simple experiments. In what respects does water differ from steam or ice ?
2. Describe the effects of heat on water in a glass flask. What is the cause of "singing" just before boiling ? Is steam visible ? What is a cloud ?
3. What happens when a jet of steam strikes a cold surface ?
4. What is evaporation ? Why is evaporation more rapid some days than others ?
5. Why do wet clothes dry more rapidly some days than others ?
6. Explain the "sweating of pitchers containing ice-water."
7. Explain the formation of clouds. Why are some clouds white, others black ? Why do clouds move ?
9. How is rain formed ? When clouds rapidly disappear what is the probable reason ?
10. Determine the conditions of formation of ice and snow.
11. Examine snow-flakes and observe their structure.
12. How could you show that water expands on being heated ? That water expands on freezing ?
13. What is a thermometer ? What is its use ?
14. Show that heat is required to melt ice.

LVIII. The Air.

1. What are the proofs for the existence of air ? Make experiments.
2. Show that air exerts pressure, is elastic, has weight, expands when warmed, and contracts when cooled (use an air-thermometer to show expansion and contraction).
3. Air is a gas. Name other gases which are also colorless and odorless.
4. Make some carbonic-acid gas and determine its properties. How do its properties differ from those of air ?
5. Why water rises when the piston is drawn up in a "squirt-gun" or syringe.
6. The barometer. Why is mercury used ? What is the use of the barometer ?
7. Winds : Their cause, direction, importance, kinds.

LIX. The Lamp or Candle Flame.

1. What part of the flame gives forth most light ? Sketch the flame.
2. By lowering a sheet of white paper upon the flame find at what part the flame is hottest by observing the areas scorched.
3. What is the use of the wick ? Is it consumed ?
4. Determine all that happens when a fine wire gauze is lowered upon a flame. Explain the phenomena.
5. Have you evidence that there is a gradual conversion of the solid tallow into a liquid, then into gas, before it burns ?
6. How can you show that free Carbon is present in the luminous part of the flame ? Explain the "smoking" of a lamp or gas jet.
7. How can you show that without air a candle will not burn ? Account for the presence of the holes in the base of a lamp-burner.
8. Show that carbon dioxide gas is formed when a candle burns.

LX. A Snow Storm.

1. What causes snow ?
2. At what temperature do snow crystals form ?
3. How do the clouds appear before a snow storm ?
4. What is the temperature of the air before the storm ?
5. What is the direction of the wind before the storm ?
6. Does the storm come in the same direction as the wind ?
7. What are the conditions of the wind and temperature when the snow crystals are most perfect in form ?
8. What are these conditions when the snow crystals are matted together in great flakes ?
9. What are these conditions when the snow crystals appear sharp and needle-like ?
10. Are the snow crystals of the same storm similar in structure and decoration ?
11. What is the difference in structure between a snowflake and a hailstone ?
12. What is sleet ?
13. What is the difference between hoar frost and snow ?
14. Does the temperature rise or fall during a snow storm ?
15. Is it colder or warmer after a storm has passed than it was before it began ?
16. What are the conditions of weather which cause a blizzard ?
17. Why does a covering of snow prevent the ground from freezing so severely as it would if bare ?

18. Why is snow a bad conductor of heat ?
19. Pack snow in a quart cup until it is full and then let it melt, and tell how full the cup is of water. What do you infer from this?
20. Have you ever observed the grass to be green beneath snow drifts ?
21. Does snow evaporate as well as melt?
22. How does the snow benefit the farmer and the fruit-grower ?
23. Do the snow storms in your locality come from one general direction all winter? (Cornell Home Nature-Study Leaflet).

LXI. A Thunder Storm.

The pupils should have access to a thermometer and a barometer, and should learn to read and to interpret the readings.

1. What is the state of the air before a thunderstorm?
2. How could you tell there was a great deal of water-vapor in the air at such a time ?
3. Is the air near the ground colder or warmer than the upper air ? How can you tell ?
4. Are there currents of air ? In what direction ? Why ?
5. Why should great banks of cumulus clouds appear ?
6. Observe carefully the growth of this bank of clouds. Why is its base flat ?
7. Why does rain fall ? What is the function of the "dust" particles ?
8. Why do hailstones often fall in a thunder storm?
9. Account if you can for the lightning and thunder. At what time of the day do thunder storms usually occur ?
10. Describe the passing away of the storm.

LXII. The Work of Rain.

Visit (1) a loose or sandy bank, and (2) a level field, after a rain storm, and study the work of the rain.

1. Ascertain where the deep furrows are made.
2. What becomes of the constituents of the bank and field when carried away ?
3. What kinds of material are carried farthest by the water ?
4. Examine a rain-pool, and, after it has dried, account for the position of the deposits.
5. Find a delta ; study its structure in detail.

LXIII. The Work of Streams.

Determine the following points after a visit to a stream (1) before rain; (2) after rain:

1. Where is the stream most rapid? In shallow or deep places?
2. The carrying power of water of different velocities.
3. The position of *bars* and other obstructions in the channel, and the causes.
4. The cause of variation in width of stream.
5. When banks are worn away, where are the materials deposited?
6. What gives the general direction to the stream?
7. Account for the depth of water at bends, and the causes of bends and windings.
8. When do streams tend to straighten their courses?
9. Account for the difference between a gorge and a wide valley.
10. Account for the presence or absence of water-falls.

LXIV. Soils.

CLASSIFICATIONS OF SOILS:

1. *Loam*, composed of equal parts of sand and clay, with some organic matter.
2. *Sandy Loam*, in which there is more sand than clay.
3. *Clay Loam*, in which there is more clay than sand.
4. *Clay Soil*, composed largely of clay.
5. *Sandy Soil*, composed largely of sand.
6. *Gravelly Soil*, containing many pebbles and small stones.
7. *Humus or Organic Soil*, composed largely of decaying organic matter, such as the black soil of swamps, decayed leaves, wood, earth, etc.

Soils are said to be *light* when sand is predominant, and as *heavy* when clay is in excess. The terms LIGHT and HEAVY do not refer to the actual weight of the soil, but to the stickiness and the amount of resistance it offers to tools of cultivation.

PROPERTIES OF SOILS:

1. *Physical Properties*, the more important being,
 - (a) Power to absorb and hold heat.
 - (b) Power to absorb and hold moisture.
 - (c) Power to absorb and hold gas.
 - (d) Power to absorb and hold plant food.

2. *Chemical Properties*, relating to the chemical composition of the soil, and the chemical changes which take place in the soil.

3. *Biological Properties*, relating to the life in the soil.

(a) The microscopic plants, Bacteria, which oxidize the materials of the soil.

(b) Those organisms which break up or decompose the soil compounds.

(c) Those organisms which enrich the soil.

(1) Collect samples of the different kinds of soils mentioned above, and label the samples in bottles or vials.

(2.) Make a map of your farm.

(3.) Locate the different soils on this farm on the map, giving a definite color to each variety of soil.

(4.) To what extent has erosion agents, such as rains, running water, etc., modified the surface of the farm since Glacial Times?

(5.) Collect or find samples of alluvial soils, residual soils.

(6.) Determine the depth of the *humus soil* in the woods; in land which has borne but one crop.

(7.) At what depth do you find the subsoil in the different fields.

(8.) To what extent are the crops of the farm influenced by differences in the soil? Are some fields better adapted for certain crops than other fields.

(9.) Determine the physical properties of the various soils collected as per question I.

LXV. Experiments with Soils.

1. The power of loose soils to retain moisture.
2. The power of compact soils to retain moisture.
3. The rate of rise of capillary water in soils.
4. Relation of texture of soils to germination.
5. Texture of different soils after rain.
6. The conservation of moisture, value of mulches.
7. Mechanical analysis of soils.

LXVI. School Gardens.

For each student: one hoe, one garden rake, one garden line, four corner pegs, two dozen 6-inch plant labels, and a note-book.

1. Special Topics for discussion and investigation:

(a) The site and aspect of the garden.

(b) The soil and its improvement by spade-work, draining and manuring.

- (c) The build of a plant.
- (d) What a plant is made of.
- (e) How plants are nourished.
- (f) Sap and its movements.
- (g) Conditions of healthy growth.
- (h) Germination, growth, flowering, fruiting, and seeding.
- (i) Annuals, biennials, and perennials.
- (j) Evergreen and deciduous trees and shrubs.
- (k) The dependence of plants upon insects.
- (l) The effect of choosing for seed the larger or smaller samples.
- (m) The effect of early and late springs on vegetation.

2. Some Arithmetic questions :

- (a) The garden account.
- (b) The number of plants to fill a given space.
- (c) The comparative cost of two plots treated differently.
- (d) The calculation of the percentage of sound seeds in a sample for a germination test.
- (e) The calculation of the loss by insects, by fungi; and the gains by beneficial birds, frogs, and insects.

3. Some Geometry problems :

- (a) The laying out of the plots by various forms.
- (b) The construction of plants to scale.
- (c) The slope of the garden.

4. Drawing in connection with School Gardens :

- (a) The making of diagrams to illustrate important facts of plant and insect life.
- (b) Drawings from nature of beautiful flowers and leaves.

5. What to plant :

- (a) Planting of bulbs, etc., in fall.
- (b) Planting of vegetable seeds in spring.
- (c) Planting of flower seeds in spring.
- (d) Planting of seedling trees.

6. *Preparation of the Bulb Bed.* Select sandy soil, if possible, if clay soil secure drainage; throw out six inches of the soil; work in two inches of manure in the bed; throw back half of top soil and plant bulbs; cover with remaining top soil. Cover with straw or leaves to a depth of six inches when crust is frozen. Remove cover gradually in April.

7. *The Planting of Bulbs for Spring.*

Hyacinths—6 inches apart.

Tulips—4 or 5 inches apart.

Narcissus—3 inches apart.

Crocusses and Snowdrops—touching one another, and from 3 to 4 inches deep.

8. *Winter Flowering Bulbs.* Oriental Narcissus and Freesia.

Place Oriental Narcissus bulb in a large bowl, in the bottom of which are some stones; fill with water and place the bowl in a warm, light place.

Place four or five freesia bulbs in a pot containing light soil; put in a warm, light place, and keep them moist.

9. Make a *Calendar* of dates of planting the various vegetable seeds when there is a succession of vegetables through the season.

10. Make a diagram showing the succession of vegetables.

11. What vegetables may be planted in fall?

12. What planting of perennial flowering plants should be done in the fall?

LXVII. Rocks and Stones.

1. *In a Gravel Pit.*

(a) Assort the stones collected with respect to (1) shape, (2) material composing them.

(b) What kind of stone is most abundant? Why are so many kinds found together?

(c) Are any of the stones like the rock found in the rocks underneath, or quarries, in the neighborhood?

(d) Account for the presence of so many stones away from a stream; also for the sand layers.

(e) What agent, or agents, has given shape to the stones?

(f) What evidences that the stones have been placed in their present position by water? Any evidences that water had nothing to do with it?

(g) Note the direction of the gravel ridge. Do other gravel ridges of district run in the same direction?

(h) What evidence that the ridge has been formed for some time?

(i) Compare the surface of stone with that of freshly broken stone. Account for the difference.

(j) Account for the coloring of some stones and beds.

2. *On the Surface of the Ground.*

(a) Visit a stone-pile in a field. Collect as many kinds as you can.

(b) What proportion is rounded? What are the names of the kinds of rocks collected?

(c) Compare the surface of exposed and freshly broken rocks.

(d) What is the nature of the soil on which the rocks were found?

(e) Account for the presence of such stones (boulders).

(f) Are they strewn evenly over the field? over the district?

(g) Find specimens of rocks which are badly decomposed, and observe the nature of the residue.

3. *In a Quarry or River-bank.*

(a) What is the composition of the rock?

(b) Are the rocks in layers? Are they horizontal?

(c) Are the layers (strata) composed of the same material? Are they of equal thickness? Try and explain the variations.

(d) Measure the Dip, and strike off the rocks.

(e) Are their fossils in the rocks?

(f) Examine the soft material lying above the rock, and determine how it has been formed.

LXVIII. The Surface Features of the District.

(From Jackman's Nature Study.)

1. In looking over the country about you, can you tell what has been the most important agent in its formation?

2. Is the same force still at work? Is it working rapidly or slowly?

3. What other forces have left their impress upon the country? Are they still acting?

4. Are there any evidences as to whether these forces ever worked more rapidly or more powerfully than now?

5. Can you find any place where the land is being torn down? What is doing it? What becomes of the material when torn away?

6. Are there any forces which oppose the tearing away?

LXIX. The Heavens at Night.

1. Determine the position of the *Great Bear*, *Cassiopeia*, *Vega*, and *Capella*, with reference to the North Star or *Polaris*. Observe their apparent rotation about *Polaris* once every day.

2. Determine the time of rotation of the earth on its axis. Describe the method.

3. Locate the position of: *Taurus* (Bull), *Perseus*, *Orion*, *Leo*, *Virgo*, *Aries* (Ram), *Pegasus*, and *Aquarius*,—Northern Crown, Northern Cross, *Scorpio*, with reference to the *Great Bear*? Explain why we cannot see *Orion* and *Leo* in a summer evening. If possible, locate the position of the constellations in early evening, at midnight, and in early morning, say 3.30. Note the changes.

4. Why does the *Great Bear* appear in early evening high up in May and low down in the Northern sky in October?

5. Determine roughly the *right ascension* and *declination* of the stars: Arcturus, Aldebaran, Sirius, Rigel, Atair, Antares, Capella, Vega, Castor, Procyon. To what constellation does each belong?

6. What constellations lie in the Milky Way? In the Ecliptic? What constellations are always above the horizon, and therefore visible at night?

7. Determine the real direction the moon travels in the sky with regard to the earth. How many degrees does it travel in 24 hours? How many in 28 days?

8. Locate the planets whenever they become visible and follow their courses. What is an evening star?

(Procure Whittaker's *Planisphere*, and Phillip's *Orrery*, and Whittaker's *Almanac*, and study carefully the movements of constellations and Planets).

LXX. Weather and Weather Observations..

Requisites: Daily weather map issued from Meteorological Observatory, Toronto, thermometer, barometer, wind-gauge, and, if possible, the maximum and minimum thermometer and hygrometer.

1. Study the daily weather-map and understand the construction of *isotherms* and *isobars*. The meaning of a number of concentric isobars.

2. Point out clearly *low pressure* and *high pressure* areas and their significance.

3. By a study of several consecutive weather-maps ascertain if the low pressure area moves. What direction? Why? How far each day? Does it follow a certain route?

4. Does a high pressure area move? In what direction? Why?

5. Examine several maps and determine the direction and velocity of the wind near a low pressure area; near a high pressure area. Can you make a general rule?

6. What effect will the direction have on the temperature of the area? Explain.

Discover if the direction of the wind determines locality of cloudiness and rain. Explain.

7. Make daily observations of the readings of the instruments, and make a record of such observations in a special note-book.

A schedule such as the following is recommended:

Time of observation

By

Date	Temperature	Barometer	Direct. of wind	Rain-fall	Cloudiness	Humidity	Frost or dew	Sun sets	Moon rises	Moon's Phase

8. Make weekly, monthly, or yearly *graphs* of the temperature, barometer, rainfall, etc.

LXXI. Some Farm Operations.

1. What system of rotation is practised on your farm? What is the advantage of a rotation? Why is it necessary?

2. What is a soiling crop? What plants may be used for soiling crops? What are the advantages of each?

3. What is a cover crop? What plants may be used for cover crops?

4. Explain the construction of a silo. What is its use? How and when is it filled? How is the silage used as feed?

5. What is the order of *seeding* in the spring? Why? What advantage in fall plowing?

6. How is the land *prepared* for seeding? The reason for the thorough cultivation? What implements are used?

7. What are the uses of drains? How are they made? When may the drains be made deep? When shallow?

8. What is hay? How cured and why? What plants are grown for hay? What machinery is used in haying?

9. When are grain crops ready to harvest? Why leave the sheaves out in *stooks* for a few days? Describe the operation of threshing. What machinery is used?

10. What advantages arise from cultivating stubble land after harvest? How to rid a badly infested field with weeds?

11. When are clover and timothy sown? Why at that time and with that crop? Why should clean seed only be used? What is meant by *seeding down*?

12. What are the uses of root crops? When and how is the land prepared for corn, for mangels, for turnips? How is each crop harvested?

13. *What is a balanced ration?* Is the ration the same for different animals?

14. Make plans for a stable suited to a 100-acre farm,—general farming.

15. What are the daily operations on your farm in winter?

16. Why should manure be cared for? When should it be applied to the land? What constituent taken from the soil is the most costly to replace? How is it replaced?

17. When and how should the orchard be sprayed? Describe the operations of preparing the solutions and applying them. Why should there be cleanliness about an orchard?

18. When should pruning be done? Why should it be done carefully? Should an orchard be cultivated and fertilized? When?

19. Describe the process of harvesting, of shipping, and of storing fruit.

20. How should milk be cared for? What need for cleanliness? For cooling? For kindness to milch cows? What are the distinguishing characters of a good milch cow? What breeds are the best milk producing breeds? How many pounds of milk should a profitable dairy cow give per year?

Some of the Most Helpful Books in Nature Study.

I. PLANTS.

1. Lessons with Plants.....	Bailey ; MacMillan & Co.....	\$1.25
2. Plants.....	Coulter ; Appleton & Co.....	1.80
3. First Studies in Plant Life.....	Atkinson ; Ginn & Co.....	.75
4. Elementary Botany.....	Bailey ; MacMillan & Co.....	1.00
5. Agricultural Botany.....	Percival ; Holt & Co.....	1.75
6. Reader and Outlines in Botany.....	Newell, 4 vols. ; Ginn & Co.....	1.70
7. Seed Dispersal.....	Beal ; Ginn & Co.....	.40
8. Sylvan Ontario.....	Muldrew ; Briggs.....	.50
9. How to Make School Gardens.....	Hemenway ; Doubleday, Page & Co.....	1.00

II. ANIMALS.

1. Animal Life.....	Jordan & Kellogg ; Appleton & Co.....	1.10
2. Animal Forms.....	Jordan & Heath ; Appleton & Co.....	1.20
3. Story of the Fishes.....	Basket ; Appleton & Co.....	.65
4. Wild Neighbors.....	Ingersoll ; Harper & Bros.....	1.50
5. Squirrels and Other Fur Bearers.....	Burroughs ; Houghton, Mifflin & Co.....	1.20
6. Birds of Village and Field.....	Merriam ; Houghton, Mifflin & Co.....	2.00
7. Bird Life.....	Chapman ; Appleton & Co.....	3.00
8. Story of the Birds.....	Basket ; Appleton & Co.....	.65
9. Manual for the Study of Insects.....	Comstock ; Comstock Publ. Co., Ithaca, N. Y.....	3.75
10. Insect Life.....	Comstock ; Appleton & Co.....	1.75
11. Stories of Insect Life.....	Weed ; Ginn & Co.....	.35
12. The Bee People.....	Morley ; McClurg & Co.....	1.25
13. The Butterfly Book.....	Holland ; Doubleday, Page & Co.....	3.00
14. The Moth Book.....	Holland ; Doubleday, Page & Co.....	4.00
15. The Insect Book.....	Howard ; Doubleday, Page & Co.....	3.00
16. How to Name the Butterflies.....	Comstock ; Appleton & Co.....	2.50
17. The Birds of New England.....	Hoffman ; Houghton, Mifflin & Co.....	1.60
18. Wild Birds in City Parks.....	Walter ; Mumford, Chicago.....	.50

III. PHYSICAL GEOGRAPHY AND GEOLOGY.

1. Elementary Geology.....	Tarr ; MacMillan & Co.....	\$1.40
2. Elementary Physical Geography.....	Gilbert & Brigham ; Appleton & Co.....	1.40
3. Elementary Geology.....	Brigham ; Appleton & Co.....	1.40
4. Physical Geography.....	Dryer ; American Book Co.....	1.25
5. H. S. Geography.....	Chase ; Can. Pub. Co.....	1.00
6. Modern Geography.....	Morang.....	.75
7. Child and Nature.....	Frye ; Ginn & Co.....	.80

IV. CHEMISTRY AND PHYSICS.

1. Simple Experiments for the Schoolroom.....	Woodhull ; Kellogg & Co., N.Y.	.50
2. Elementary Physics and Chemistry	Gregory & Simmons ; MacMillan & Co.....	.50

V. NATURE STUDY.

1. Nature Study and the Child...	Scott ; D. C. Heath	1.50
2. Nature Study and Life.....	Hodge ; Ginn & Co.....	1.50
3. Guide to Nature Study	Crawford ; Copp, Clark Co.....	.90
4. Modern Nature Study	Silcox & Stevenson ; Morang...	1.00
5. Nature Study for Common Schools	Jackman ; Holt & Co.....	1.20
6. The Nature Study Idea	Bailey ; Doubleday, Page & Co..	1.00
7. Public School Nature Study ...	Crawford, and others ; Copp, Clark Co.	.50

VI. NATURE READERS.

Friends Worth Knowing	Ingersoll ; Harper & Bros.....	1.00
Ways of Wood Folk.....	W. J. Long ; Ginn & Co.....	.65
Wilderness Ways.....	W. J. Long ; Ginn & Co.....	.65
Wild Animals I Have Known.....	Seton-Thompson ; Scribner.....	2.00
Lives of the Hunted.....	Seton-Thompson ; Scribner.....	2.00
Nature Pictures	American Poets ; MacMillan & Co.....	1.25
Poetry of the Seasons.....	Lovejoy ; Silver, Burdett & Co...	.60
Nature in Verse.....	Lovejoy ; Silver, Burdett & Co...	.60
Little Wanderers.....	Morley ; Ginn & Co.....	.35
Flowers and Their Friends.....	Morley ; Ginn & Co.....	.60

Nature Study or Stories in

Agriculture Staff O. A. C.

Nature Study Bulletins and

Leaflets (Cornell) Humphrey, Geneva \$1.00

Songs of Nature Burroughs ; McClure, Phillip &
Co. 1.00

Nature Biographies Weed ; Doubleday, Page & Co...

Flashlights from Nature Grant-Allen ; Briggs

Nature's Garden Blanchan ; Doubleday, Page & Co.

The Study of Animal Life Thomson ; Murray

Wild Life Near Home Sharp ; The Century Co.

A Hermit's Wild Friends Walton ; Dana, Estes & Co. 1.50

Wake Robin, Birds and Poets,

Locusts and Wild Honey,

Winter Sunshine Burroughs ; D. Douglas 1.00

INDEX.

	PAGE		PAGE
Air	32	Leaf-fall	7
ANIMALS :		Legumes	14
Adaptations	20	Logs	11
Coverings	19	Lumber	11
Domestic	18	Mangel	9
Food-getting	19	Meteorological Records	41
Movements	19	Mosquitoes	23
Ants	27	Nasturtium, Garden	6
Apple Host	15	Nuts	17
Apple Twig	12	Oyster-shell Scale	28
Aquarium	3	Pear Slug	28
Autumn Insects	29	Physiology, Plant	9
Bean	8	Plant Societies	3
Birds	30	Potato	24
Books	43	Potato Beetle	29
Butter and eggs	5	Rain	35
Candle Flame	33	Robin	31
Carrot	24	Rocks	39
Conifers	10	Rose Family	14
Constellations	40	Rust of Wheat	22
Cow	18	School Gardens	37
Crow	30	Seeds	8
Currant Saw-fly	27	Sheep	18
Dandelion	6	Skunk-cabbage	5
Development of Apple and Cherry ..	13	Slugs	20
Dissemination of Seeds	18	Snails	20
Dog	18	Snowstorm	34
Earthworms	25	Soils	37
Experiments with Plants	9	Songs of Insects	26
Farm Operations	42	Sparrow	30
Flower Calendar	4	Spiders	24
Flowers	5	Spring Flowers	5
Fruits	16	Spruce Gall Louse	28
Frog	22	Spurs	12
Galls	25	Squirrels	32
Germination	8	Stars	40
Grasses	15	Steam	33
Heavens at Night	40	Stones	39
Hepatica	5	Streams	35
House-fly	27	Sunflower	5
Horse	18	Sundew	21
Ice	33	Surface Features	40
Insects	29	Terrarium	3
Jack-in-the-Pulpit	5	Thunder-storm	35
Knots	11	Toad	22
Lady-birds	29	Trillium	5
Lamp Flame	33	Trees	13
Larch Saw-fly	28	Turnip	24
Leaf	7	Water	33
		Weather	41
		Woods, coniferous	11
		Woods, dicotyledonous	18
		Woodpeckers	30

Ontario Department of Agriculture.

ONTARIO AGRICULTURAL COLLEGE.

DAIRY SCHOOL BULLETIN.

INTRODUCTION.

BY H. H. DEAN, B.S.A., PROFESSOR OF DAIRY HUSBANDRY.

The bulletins which have been prepared by the members of the Dairy School Staff at the Ontario Agricultural College appear to have been appreciated, and there is a great demand for them. We trust that this one will prove as helpful as those published in the past. The aim is to make the bulletin popular and practical. In some departments there is not much change from the last. Our system of buttermaking has undergone more changes than any other branch of dairy work, and there is yet great room for improvement. We hope that the bulletin will prove useful for the man who cares for and milks the cows, and also to the manufacturers of cheese and butter in the factory and on the farm.

DAIRY FARMER. Many dairy farmers grow discouraged during the season of low prices and sell their cows. This is a great mistake. No branch of agriculture is so stable and so remunerative as dairying during a series of years. A year of low prices is usually followed by one of high prices. The cow is undoubtedly the best paying animal on the farm if she is fed and handled properly. However, in order to make a cow pay it is necessary that her owner shall possess certain qualifications. The most important of all is that he shall have a real liking for the cows, not only because of the money which they earn, but he must like them simply because they are cows. A person who really likes cows will take pleasure in feeding and looking after them. To him it is not drudgery. This person will always treat cows kindly and considerately. There will always be a bond of sympathy between the owner and the cow. Each will strive to do the best possible for the other.

This owner of cows must study their habits, likes, and dislikes. He must feed them liberally and make them as comfortable as possible. Unless he or she is prepared to be a student of cows, success is not probable. To the dairy farmer we should say, know your cows *individually*. This can be best done by weighing the milk from each cow daily, once a week, on two consecutive days each month, or even once a month. Samples for testing should also be taken on the day or days for weighing in order to know the percentage of fat in the milk. This, together with

a close observation of the feed consumed by a cow, will enable a dairy farmer to determine whether or not his cows are making a profit. It will also enable him to intelligently weed the poorer cows.

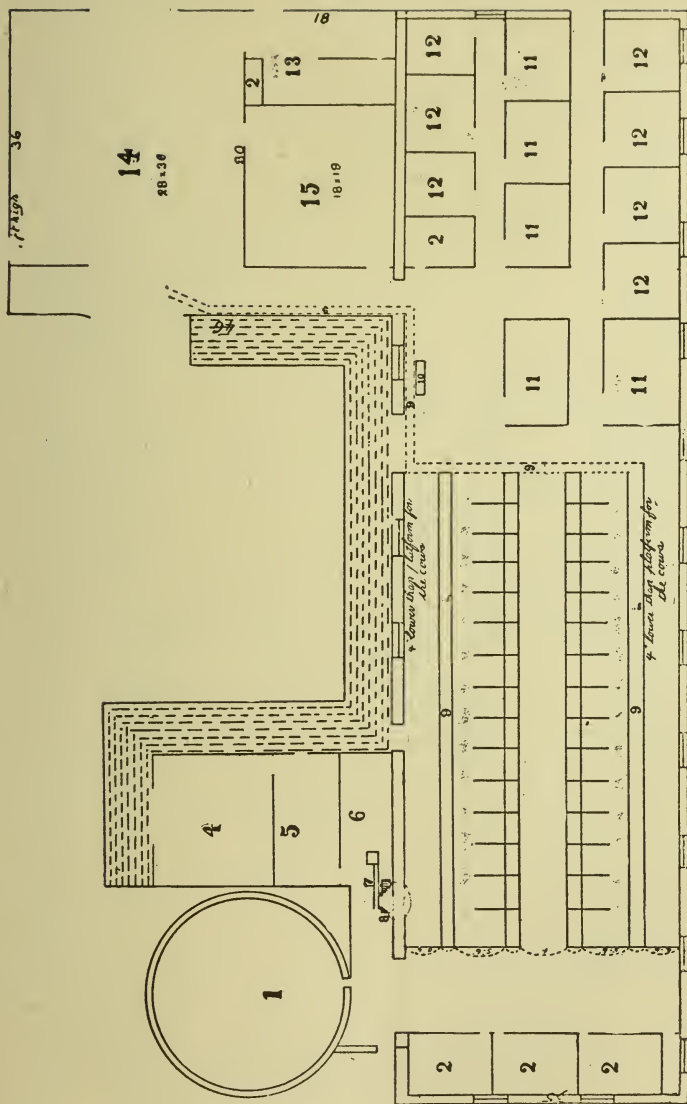
DAIRY COWS may be purchased or they may be bred. Frequently good cows may be bought at reasonable prices, but generally speaking they must be reared by the dairy farmer. For the dairyman who cannot afford to keep pure-bred cows, it is desirable to select grade or native cows and breed these to a pure-bred male belonging to one of the dairy breeds. Great attention should be paid to the sire, as milking quality in the female depends more on the sire than on the dam. Dairy farmers do not sufficiently realize the importance of this point. Excellent dairy cows may be secured at small cost by using a dairy sire belonging to a dairy breed and a dairy family. In this way a herd of ordinary or inferior breeding may soon be transformed into a herd of good milkers. The fundamental mistake made by many breeders of dairy cows is in the use of inferior or what are commonly called "scrub" sires. The patrons of every cheese factory and creamery ought to have the use of a pure-bred bull at nominal cost. It would pay the factories to adopt some co-operative plan to secure this result.

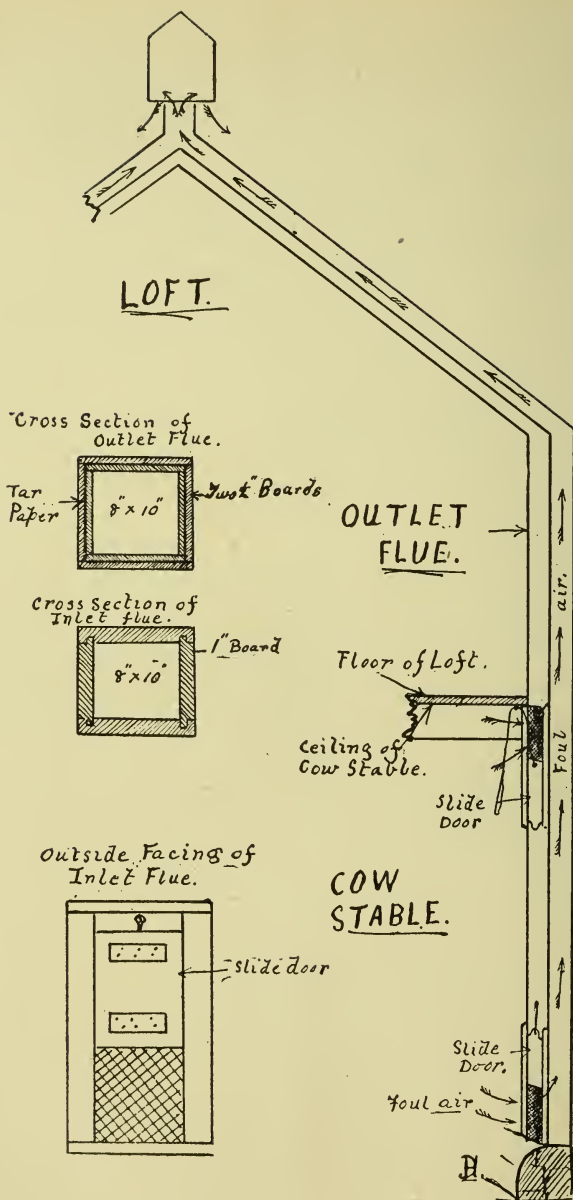
Calves and heifers for the dairy should be kept in a thrifty condition but not too fat. They should commence milking when about two and one-half years old. At the end of the second lactation period and during all future years they should produce not less than 6,000 lbs. milk or 250 lbs. butter yearly. This may be taken as a minimum standard of production for profitable dairy cows. Stated another way, they should earn from \$25 to \$100 per cow each year, above the cost of feed.

DAIRY STABLE. The chief requirements in a dairy stable are that it shall be light, clean, and healthful. The first is got by having plenty of clean windows, the second by having cement floors, with stalls of proper length and a gutter or drop behind the cows, and the last by having the stable well ventilated, and whitewashed at least once a year. Mangers are not necessary in a modern cow stable.

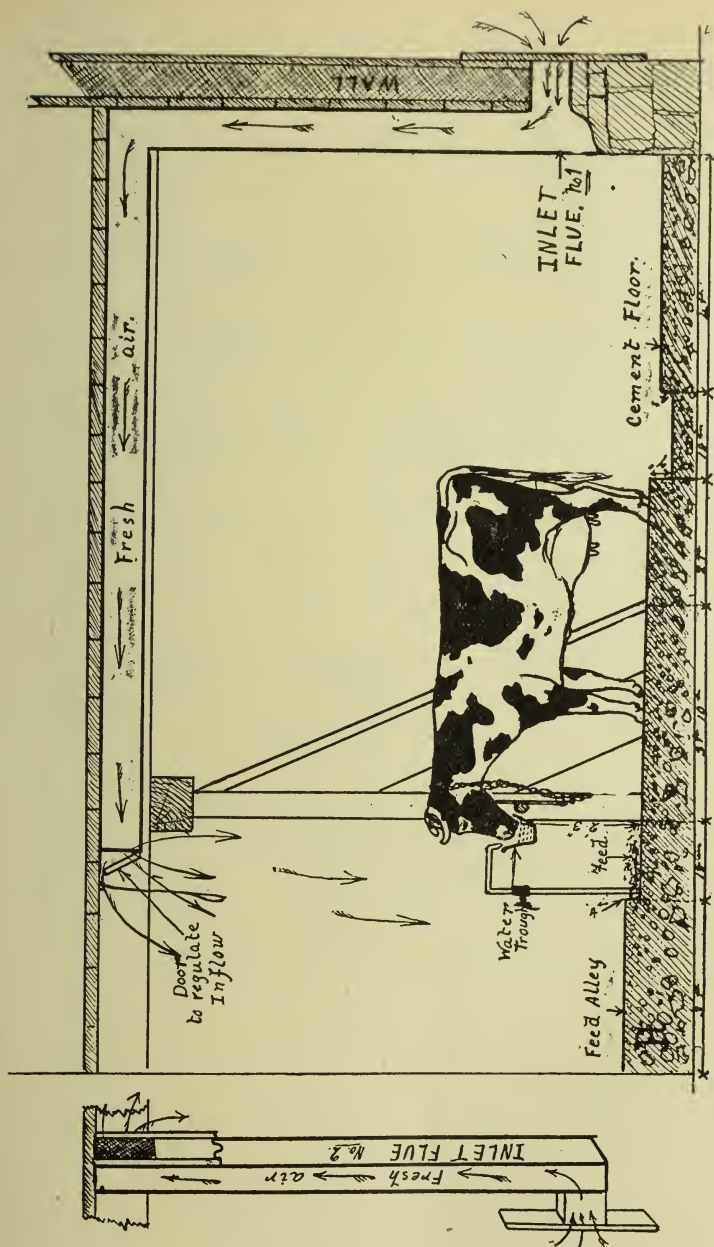
Conditions vary so much on different farms that it is difficult to give a plan suitable for all farms. The accompanying illustrations will show the arrangements in the dairy stable of the College, and on the whole it is quite satisfactory. The feed bins are located at one end of the stable and the box stalls, eleven in number, at the other. There is room for thirty cows to be tied up. A large room above the stable holds the hay and straw. This is not the most sanitary arrangement, but it is convenient.

The King system of ventilating is the one adopted in the dairy stable and it is quite satisfactory. There are six inlets and eight outlets. The cost of putting in the ventilation was \$136, including the cost of galvanized iron ventilators, of which there are four connected with the eight outlets from the stable.





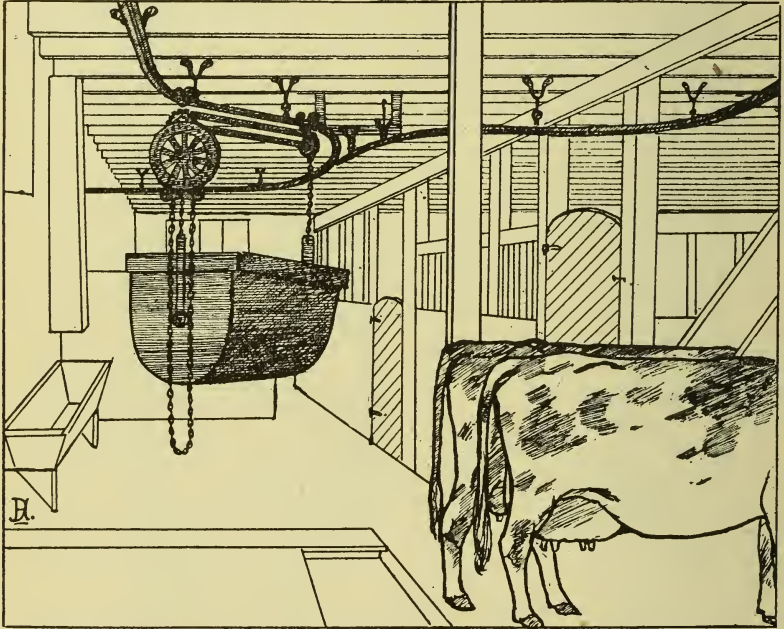
Plan showing outlet for foul air. There are eight of these in the stable—four on each side. One from each side enters a ventilator at roof.



Cross section of stable showing one-half the feeding alley, place for feeding, water trough, stall, gutter, passage behind the cows and inlets for fresh air. There are six of these, one-half of which open at the ceiling behind the cows and one-half in the centre of the stable.

FEEDING THE COW. The natural food of the cow is grass, and nothing is equal to good pasture for cows. In order to secure good pasture on cultivated land it is advisable to give more attention to the method of, and mixture used for, seeding. A very good combination of grasses and clovers, where a rotation of crops is practised, is the following: 4 lbs. timothy, 5 lbs. orchard grass, 7 lbs. red clover, and 2 lbs. alsike clover, making 18 lbs. of seed per acre.

On fields which may be allowed to remain in pasture for several years, the following mixture is recommended by Prof. Zavitz: 4 lbs. orchard



Litter carrier, a great convenience for cleaning Dairy Stable.

grass, 4 lbs. meadow fescue, 3 lbs. tall oat-grass, 2 lbs. timothy, 2 lbs. meadow foxtail, 5 lbs. lucerne clover, 2 lbs. alsike, and 2 lbs. white clover, making 24 lbs. of seed per acre.

The same authority recommends for a pasture crop to be used the same year as sown, 51 lbs. oats, 30 lbs. early amber sugar cane, and 7 lbs. red clover—a total of 88 lbs. per acre. Cows are very fond of this mixture.

Lucerne or Alfalfa is another crop which dairy farmers should grow. It may be used for green fodder, hay, pasture, and for green manure. For hay it should be cut when less than one-third in bloom. It is claimed that a ton of lucerne hay is equal to a ton of bran for milk production. This crop should receive more attention on dairy farms. About 18 lbs.

of seed per acre should be sown on well-drained land in the spring, with or without a crop. It should not be pastured or cut the *first* year. It will give two or three cuttings each year after it is established.

To supplement pastures, green peas and oats, or summer silage are often necessary. These help to maintain the milk flow at a time when the shrinkage would otherwise be considerable. From two to four pounds of meal per cow each day will often pay when the prices of dairy produce are good. This meal may consist of bran and oats, or either of them alone.

For winter feeding, corn silage is undoubtedly the cheapest bulky food at the disposal of dairymen. However, corn silage alone is not sufficient for milking cows. They also need some clover hay, roots, and meal. When dry it pays to feed the cows a moderate amount of meal, as it seems to be a recognized principle that the time to renew a cow is when she is not milking. Too many put their cows on short rations when they are not milking, thus violating the foregoing principle, and the results are not satisfactory. It pays to feed a good cow well when dry. With heavy milkers there is danger of losing the cows through "milk fever," but modern methods of treating this disease make it comparatively harmless, and there is very much less risk now than formerly. Under ordinary conditions the best plan with heavy milkers in high flesh is to not milk the cow any more than is required for the calf for the first two or three days. If the cow is attacked, the "air treatment" is simple and effective.

On the one hand many cow feeders fail to give their animals sufficient to maintain a proper milk flow, while on the other some feeders give more meal than the cows can profitably assimilate. Experiments indicate that cows in full flow of milk should receive about eight pounds of meal daily, together with all the roughage which they can consume. An increase to twelve pounds of meal daily in most cases means an added cost for the milk and butter out of proportion to the increased yield.

The winter feed at the dairy barn of the College is prepared as follows: The hay is cut and mixed with the corn silage and pulped mangels for several hours before feeding. This roughage is given at two feeds, and on it is placed the meal for each cow at the time of feeding. The meal usually consists of bran, oats and oilmeal. A feed of long hay is given once a day in addition to the regular feed.

Our standard ration consists of about

40 lbs. corn silage,
10 lbs. clover hay,
30 lbs. mangels,

4 lbs. wheat bran,
3 lbs. ground oats,
1 lb. oil meal.

The following table is based on Bulletin 154 from Cornell Station :

DIGESTIVE NUTRIENTS IN ONE POUND OF SOME COMMON FEEDING STUFFS.

Kind of Food	Total dry matter.	Pounds of digestible nutrients.			Nutritive Ratio.
		Protein.	Carbo-hydrates. + (fat x 2.25).	Total.	
Green fodder corn, 1 lb.....	0.20	0.010	0.125	0.135	1:12.5
“ peas and oats, “	0.16	0.018	0.076	0.094	1:4.2
“ red clover, “	0.29	0.029	0.164	0.193	1:5.6
“ alfalfa clover “	0.28	0.039	0.138	0.177	1:3.5
Corn silage, “	0.21	0.009	0.129	0.138	1:14.3
Potatoes, “	0.21	0.009	0.165	0.174	1:18.3
Mangles, “	0.09	0.011	0.056	0.067	1:5.1
Sugar beets, “	0.13	0.011	0.104	0.115	1:9.4
Carrots, “	0.11	0.008	0.082	0.090	1:10.3
Turnips, “	0.10	0.010	0.077	0.087	1:7.7
Timothy hay, “	0.87	0.028	0.465	0.493	1:16.6
Mixed hay, “	0.87	0.062	0.460	0.522	1:7.4
Red clover hay, “	0.85	0.068	0.396	0.464	1:5.8
Alfalfa hay, “	0.92	0.110	0.423	0.533	1:3.8
Corn fodder, “	0.58	0.025	0.373	0.398	1:14.9
Corn stover, “	0.60	0.017	0.340	0.357	1:19.9
Pea straw, “	0.86	0.043	0.341	0.384	1:7.9
Wheat straw, “	0.90	0.004	0.372	0.376	1:93
Oat straw, “	0.91	0.012	0.404	0.416	1:33.6
Corn, (grain) “	0.89	0.079	0.764	0.843	1:9.7
Wheat, “	0.90	0.102	0.730	0.832	1:7.2
Rye, “	0.88	0.099	0.700	0.499	1:7.1
Barley, “	0.89	0.087	0.692	0.779	1:7.9
Oats, “	0.89	0.092	0.568	0.660	1:6.2
Buckwheat, “	0.87	0.077	0.533	0.610	1:6.9
Peas, “	0.90	0.168	0.534	0.702	1:3.2
Corn and cob meal, “	0.85	0.044	0.665	0.709	1:15.1
Wheat bran, “	0.88	0.122	0.453	0.575	1:3.7
Wheat middlings, “	0.88	0.128	0.607	0.735	1:4.7
Low grade flour, “	0.88	0.082	0.647	0.729	1:7.9
Gluten feed, “	0.92	0.194	0.633	0.827	1:3.3
Gluten meal, “	0.92	0.258	0.656	0.914	1:2.5
Linseed meal (new process) 1 lb.....	0.90	0.282	0.464	0.746	1:1.6
Cotton seed meal, “	0.92	0.372	0.444	0.816	1:1.2
Sugar beet pulp, “	0.10	0.006	0.073	0.079	1:12
Apple pomace, “	0.233	0.011	0.164	0.175	1:14.9
Skim-milk (separator) “	0.094	0.029	0.059	0.088	1:2
Buttermilk, “	0.10	0.039	0.065	0.104	1:1.7

To find the pounds of nutrients in any given number of pounds of any feeding-stuff multiply the pounds by the amount of nutrients in one pound as given in the table.

By referring to the preceding table we find that our ration contains digestible material as follows :

Feeding Stuffs.	Total dry matter.	Pounds of digestible nutrients.			Nutritive ratio.
		Protein.	Carbo-hydrates. + (fat x 2.25.)	Total.	
Corn silage, 40 lbs.	8.40	0.360	5.160	5.520	.....
Clover hay, 10 "	8.50	0.680	3.960	4.640	.....
Mangels, 30 "	2.70	0.330	1.680	2.010	.....
Bran, 4 "	3.52	0.488	1.812	2.300	.....
Oats, 3 "	2.67	0.276	1.704	1.980	.....
Oil-cake, 1 lb.	0.90	0.282	0.464	0.746	.....
	26.69	2.416	14.780	17.196	1:6.1
Wisconsin standard	24.5	2.20	14.900	17.100	1:6.8
German "	24.0	2.50	13.400	15.900	1:5.4

By comparing it with the Wisconsin and German standards, we find that it contains more dry matter than is called for by either, more protein than is asked for in the Wisconsin and less than the German, more carbonaceous material than the German and slightly less than in the Wisconsin, the total digestible material is greater than in the German and about the same as the Wisconsin, while its nutritive ratio is between the two standards, but conforming more nearly to that of Wisconsin.

By using the table as directed any farmer can readily find out the amount of digestible material in his ration and compare it with the standards given. If he finds that the ration is too low in protein or muscle-forming material, then bran, oil-meal, gluten meal, peas or clover hay should be added to the ration, and if necessary some of the more carbonaceous foods such as silage, may be reduced. However, silage, roots, beet pulp, etc., give succulency to the ration which is very important in the economical production of winter milk.

FACTORY FLOORS. Substitute, as soon as possible, a cement floor for the wooden floor now in the factory. Grade the ground to a slant of one inch in six feet to a central gutter, then pack the earth firmly and cover with four to six inches of gravel. Pound the gravel solidly. Mix sand and gravel with good cement in the proportion of four or five to one, and lay the grouting about four inches thick on the firm gravel. Finish with one inch of screened sharp sand and the very best brand of cement mixed in the proportion of two to one for the finishing coat. Have the surface smooth so that pools of water will not lie on the floor. The gutter should

have a fall of one inch in six to eight feet, to an outlet, and should be made specially solid and even on the side and bottom. Employ a skilled workman to lay the floor, and use none but the very best material.

Place a "bell-trap" at the outlet from the gutter. Use sewer tile with cemented joints in underground drains near the factory, to prevent sewage soaking into the well. The sewage may be disposed of by means of a filter-bed or by the sub-earth system. Do not allow it to accumulate about the factory.

PAYING PATRONS. Milk is valuable for buttermaking in proportion to the fat which it contains, and the pounds of fat delivered in the milk or cream should form the basis of dividing proceeds among patrons of the creameries.

As butter consists of fat, together with about 16 per cent. of water, salt, and curdy matter, there will always be more butter than the fat contained in the milk. This excess of butter over fat constitutes what is known as the "overrun." The "overrun" varies from 12 to 16 per cent., *i.e.*, 100 lbs. fat in the milk makes from 112 to 116 pounds of butter, and this "overrun" belongs to the patrons, unless otherwise understood. It is unwise for creamery managers to take the "overrun" as part payment for manufacturing.

In cream-collecting creameries the overrun usually varies from 12 to 18 per cent.

For calculating the yield of butter from fat in the milk, adding one-sixth to the fat is near enough for practical purposes.

Cheese is made largely from two constituents in the milk, *viz.*, fat and casein; therefore, the method of dividing proceeds among the patrons of cheese factories is more complicated than for creameries. Three systems are now in use among factorymen:

1. Paying according to the weight of milk delivered regardless of its quality.

The principle of this plan is that all milk is of equal value per 100 pounds for cheese-making. It rests on a false assumption, is unjust, and it tends to promote dishonesty. Factorymen and honest patrons who complain that some of the milk is skimmed and watered by dishonest patrons, deserve little sympathy, because a remedy is within the reach of all at a very small cost. The milk of all patrons should be tested regularly, and be paid for according to its value for cheesemaking.

2. Paying according to the weight of the fat delivered in the milk, the same as at creameries.

The principle of this system is that all milk is valuable for cheese-making in proportion to the fat which it contains. The system is manifestly more just and equitable than the first named, and is to be commended in preference to "pooling" by weight of milk. The chief weakness of the plan is that the yield of cheese is not in direct proportion to the fat contained in the milk; therefore, it gives an undue advantage to the patrons sending milk containing a high percentage of fat.

3. Paying according to the fat and casein in the milk, the casein being represented by the factor 2, added to the percentage of fat.

The principle of this system is that milk is valuable for cheesemaking in proportion to the fat and casein contained in it, and it further assumes that the percentage of fat $+ 2$ represents the available fat and curdy compounds in milk for cheesemaking.

The application of the third system is very simple. To illustrate: The tests for fat of patrons' milk are 3.0, 3.5, 3.8 and 4.0. The percentage of fat and casein are $3 + 2 = 5.0$; $3.5 + 2 = 5.5$; $3.8 + 2 = 5.8$; and $4 + 2 = 6.0$. The pounds of fat and casein are calculated by multiplying the pounds of milk delivered by the percentage of fat and casein. Thus, if the first patron had 1,500 lbs. milk he would be credited with $1,500 \times 5 \div 100 = 75$ pounds of fat and casein. If the second delivered 2,000 pounds milk he would be credited with $2,000 \times 5.5 \div 100$, or 110 pounds of fat and casein, and so on with all the others. The value of one pound of fat and casein is ascertained by dividing the net proceeds of the sale of cheese by the total pounds of fat and casein delivered.

The following table gives a summary of the results obtained during five years' experiments, in which 250 experiments were made with nearly 200,000 pounds of milk, which contained percentages of fat varying from 2.7 to 5.5.

Av. p.c. fat in milk.	Lbs. cheese made per 100 lbs. milk.	Lbs. cheese made per 1 lb. fat in milk.	Lbs. cheese made per lb. fat and casein or p.c. fat $+ 2$.	Lbs. loss of fat and casein in whey.		Percent. lost in curing in four weeks.	Average score.	
				Per 1,000 lbs. milk.	Per 100 lbs. cured cheese.		Flavor max. 35.	Total max. 100.
2.87	8.75	3.04	1.79	2.71	3.09	4.26	30.4	89.9
3.22	9.03	2.80	1.72	2.75	3.15	4.43	30.2	89.4
3.83	10.02	2.61	1.71	3.34	3.21	4.10	30.8	90.3
4.23	10.67	2.53	1.71	3.21	3.02	4.05	31.0	90.4
4.74	11.44	2.41	1.69	3.64*	3.18*	3.07	31.0	89.8
5.21	12.13	2.32	1.68	3.40*	2.80*	3.53	31.5	91.6

* Fat only. Casein not determined.

Amounts of money (cheese 8c per pound) credited by three systems and also value of cheese.

Average p. c. fat in milk	Weight of milk— 1,000 lbs. milk.	Weight fat in 1,000 lbs. milk.	Weight of fat and casein in 1,000 lbs. milk, or fat plus 2.	Value cheese made from 1,000 lbs. milk.
	\$ c.	\$ c.	\$ c.	\$ c.
2.87	8 27	5 91	6 69	7 00
3.22	8 27	6 63	7 18	7 22
3.83	8 27	7 89	8 02	8 02
4.23	8 27	8 71	8 56	8 54
4.74	8 27	9 76	9 27	9 15
5.21	8 27	10 73	9 91	9 70

"Our five years' experiments prove that this third system comes nearest to the actual value of the cheese produced, though it still places a slight premium on the milk-fat. It encourages the production of good milk, and at the same time does not discourage the majority of patrons who have average milk, and who are apt to envy those whose cows give a small amount of rich milk, and who draw a large share of the proceeds of cheese-sales, when the money is divided on the basis of the fat only."—O.A.C. Report, 1898, p. 52.

The Hart casein test, if it proves satisfactory, will enable us to obtain more accurate results, but is not likely to change the principles of this third method.

SKIM MILK AND WHEY. The value of skim milk for young calves and pigs is much increased by feeding it sweet. The separator creamery should heat all skim milk to 185 degrees, before it leaves the creamery. Sweet skim milk is probably worth 15 to 20 cents per 100 pounds. It has also about the same value for grown pigs when sour, if fed along with meal.

Buttermilk has about the same value as sour skim milk, if it does not contain too much water. When selling buttermilk in bulk at the creamery a convenient way is to value it at so much per ton of butter. From three to five dollars per ton of butter is a fair price.

Experiments made at the Ontario Agricultural College showed that 100 pounds of whey were equal to 14 pounds of meal in the production of bacon. Both skim milk and whey had a marked influence in the production of *firm* bacon. When selling whey in bulk at the factory, it is usually valued at from three to six dollars per ton of cheese.

The by-products of cheesemaking and buttermaking are valuable factors in adding to the wealth of dairymen through bacon hogs, and the rearing of young cattle for beef and the dairy.

All these by-products ought to be pasteurized at the factory before returning them to the farm. Whey heated to 160° F. for one hour in the whey tank will destroy the germs which produce tuberculosis in hogs and other animals. All cheese factories ought to heat the whey. It improves the feeding quality, lessens danger of spreading disease, and reduces danger from bad flavors in milk and cheese, as the organisms causing these flavors are killed by heating. The cost has been estimated at 50 cents per ton of cheese made.

THE ALKALINE SOLUTION : ITS PREPARATION AND USE.

BY R. HARCOURT, B.S.A., PROFESSOR OF CHEMISTRY.

CAUSES OF ACIDITY IN MILK. The development of acid is caused by the breaking down of milk sugar into lactic acid, through the influence of certain acid-forming ferments in the milk. But even sweet milk, immediately after it is drawn from the udder, will have an acid reaction with certain indicators. This acidity is not due to lactic acid nor any free acid in the milk, but to the acid nature of the ash constituents, possibly also to the carbonic acid gas it contains, and to the acid nature of the casein. When phenolphthalein is used as an indicator, freshly drawn milk will generally show as much as .10 per cent. of acid and immediately after exposure to the atmosphere, lactic acid germs commence breaking down the milk sugar. At a temperature of 70° to 90° F., these germs multiply at an enormous rate, consequently lactic acid will develop very rapidly in milk during a warm or sultry day or night. Cooling retards the action, but even at a temperature of 40° to 50° F. they will multiply and considerable lactic acid will be formed. Milk intended for cheesemaking should not contain more than .20 per cent. acid when delivered at the factory; whereas it does not usually smell or taste sour until it contains .30 to .35 per cent. A further development of acid will cause the milk to curdle, or, in other words, will produce coagulation of the casein. There is, however, a limit to the development of acid; for, after a certain point, the germs which break down the milk sugar are destroyed by the acid they produce, and there is no further increase in acidity.

In many ways a knowledge of the acid contents of milk or its products is of value. In most cases, a determination of the percentage of acid in the milk when delivered at the factory will indicate the care the milk has received previous to that time. The acid test may be of value in selecting milk best adapted for pasteurization, or for retail trade, or manufacture of high-grade products. At the present time, however, the chief uses made of the alkaline solution in dairy work are to determine the acid in cream intended for churning, and the acid in milk and whey in the various steps in the process of the manufacture of cheese. Both in ripening cream and in cheesemaking, acid is developed, and the alkaline solution is now frequently used to measure the amount of acid present and thus control the work.

HOW TO MEASURE THE ACIDITY. The measurement of the amount of acid or alkali in a solution depends upon the fact that it always takes a definite quantity of alkali to neutralize a definite quantity of acid. Thus, for instance, it always takes a definite quantity of caustic soda to neutralize a definite quantity of lactic acid, sulphuric acid, or any other acid. If, then, we know the strength of a given caustic soda solution and measure the amount of it used to render a definite amount of milk or cream neither acid nor alkaline, but neutral, we can figure the amount of acid in the

sample taken. To make such a determination we require the following :

1st. A standard solution of caustic soda, usually made of the strength known as .111 normal.

2nd. An indicator—some chemical which, added to the milk, indicates by change of color when enough of the alkaline solution has been added to render the milk neutral. Phenolphthalein is the one most commonly used for this purpose. It is made by dissolving 10 grams of phenolphthalein in 300 c.c. of 80 per cent. alcohol.

3rd. A burette, graduated to 1-10 of a cubic centimeter, in which to measure the amount of solution used.

4th. A pipette, to measure the milk or cream.

5th. A glass or porcelain cup, and a stirring rod. A complete outfit suitable for use in butter and cheese factories may now be procured from almost any of the dairy supply firms.

For the information of those who want to make their own alkaline solution or who may wish to check the strength of a solution on hand, the following directions are given :

PREPARATION OF SOLUTIONS. The caustic soda solution may be prepared by a druggist or one who has a delicate balance at hand by carefully weighing out 4.4 grams of pure sodium hydroxide and dissolving in one litre (1,000 c.c.) of water. But impurities in the sodium hydroxide and lack of delicate enough balance make this method unreliable.

The most accurate way of preparing this solution is by standardizing it against an acid diluted to the same strength as the alkaline solution wanted. As it requires an experienced chemist to prepare this acid of the strength required, it is important that it be got from a reliable source.

Having on hand, then, a .111 normal solution of acid, the object is to make a solution of the alkali, 1 c.c. of which will exactly neutralize 1 c.c. of the acid. For this purpose, dissolve about 5 grams sodium hydroxide (NaOH) in one litre of water. If the soda contains much carbonate, it must be removed by adding a little of a solution of barium hydroxide, boiling, and filtering off the precipitated carbonates. The relative strength of the acid and alkali solution is next determined. This is done as follows :

Rinse out a clean burette two or three times with the acid solution, and then fill it with the same. Note the exact point at which the surface of the liquid stands in the burette; measure out 10 c.c. of the alkaline solution, and deliver into a clean beaker, glass or porcelain cup. Dilute with about 50 c.c. of water, add three or four drops of the phenolphthalein indicator, and then stirring all the time, let the acid from the burette drop slowly into the alkaline solution, until the color first produced by the indicator is just destroyed. This is the neutral point. Now, again note the exact point at which the surface of the liquid stands in the burette. The difference between the two readings is the amount of acid required to neutralize the 10 c.c. of alkali. If care be taken in coming to the neutral point slowly, it will be seen that one drop finally destroys the last of the

light pink color. This work should be repeated until accuracy is assured. The following is an example of results:

- 1st. 10 c.c. of alkali required 11.5 c.c. of acid for neutralization.
- 2nd. 10 c.c. of alkali required 11.45 c.c. of acid for neutralization.
- 3rd. 10 c.c. of alkali required 11.5 c.c. of acid for neutralization.

In this case, we would accept 10 to 11.5 as the relative strength of the two solutions. The alkali is, therefore, the stronger, and must be diluted. If 1.5 c.c. of water be added to 10 c.c. of the alkali solution, 1 c.c. of the alkali ought exactly to neutralize 1 c.c. of the acid. Therefore, for every 10 c.c. of the alkali solution add 1.5 c.c. of water. Measure out the amount of the solution and pour into a clean dry bottle. Calculate the amount of water required to dilute the alkali to the proper strength, and add it to the contents of the bottle. Mix well, and test correctness of work by proving that 10 c.c. of the one solution will exactly neutralize 10 c.c. of the other. If it does this, the solution is correct.

TESTING THE ACIDITY OF MILK OR CREAM. By means of a pipette (a 10 c.c. is a convenient size) measure out a definite quantity of the milk or cream to be tested and deliver into a beaker or cup. If distilled or rain water is handy rinse out a pipette once, and add the rinsings to the sample. Dilute with 50 c.c. of water, and add three or four drops of the indicator. Now, having the alkaline solution in the burette, carefully note the point at which the surface of the liquid stands in the burette and then cautiously let it drop into the cream or milk being tested. Keep the sample well stirred while adding the alkali. The acid in the sample will gradually be neutralized by the alkali added until at last a uniform pink color appears, which will slowly fade away. The most delicate point is the first change to the uniform pink color, which the sample shows when the acid contained therein has been just neutralized. Because of the influence of carbonic acid of the atmosphere the pink color is not permanent unless a slight excess of alkali solution has been added. The operator should not, therefore, be led to believe by the disappearance of the color after a short time, that the neutral point has not been reached. Having decided on the neutral point, again read the burette at the surface of the liquid, and the difference between this reading and the first is the amount of alkali solution used to neutralize the acid in the sample taken.

The calculation of the per cent. of acid is simple. The alkaline solution used is of such a strength that when a 10 c.c. pipette is used, the number of cubic centimeters of alkaline solution required to neutralize the acid in the milk or cream has simply to be multiplied by 0.1. Thus, if 5.6 cubic centimeters of the alkali be used then $5.6 \times 0.1 = .56$ per cent. acid.

To insure accuracy the utmost care and cleanliness must be observed in every detail of the work. All water used with the milk or cream or in making the alkaline solution should be either distilled or pure rain water. The burette and pipette, after being washed, must be rinsed out two or three times with the solution they are intended to measure.

The knowledge the operator may gain from such tests will not only make it possible for him to turn out more uniform products, but it will also enable him to act with confidence and more intelligently to pursue the work he may have on hand.

MILK AND CREAM TESTING.

By J. A. McFEETERS.

Normal milk may be considered as an emulsion. The chief constituents are fat, casein, sugar, albumen, a small amount of mineral matter—ash, together with a large percentage of water.

As fat is the most variable of the milk constituents, the ability to accurately determine the percentage present is an essential qualification for a successful dairyman.

The importance of this becomes at once apparent under conditions where the commercial value of milk is in direct proportion to its fat content. A means of detecting mechanical losses, due to faulty methods in the course of manufacture, adulterations by the producer or dealer, or of testing the real worth of the different members of the dairy herd, is of inestimable value to a dairyman.

The details connected with an accurate, speedy fat determination of a normal sample of milk, by means of the Babcock test, are briefly as follows:

1. After thoroughly mixing, preferably by pouring from one vessel to another, a *representative* sample should be taken. Too great care cannot be exercised at this step. A test is of no value whatever if this point be overlooked.

2. By means of a 17.6 cubic centimeter (c.c.) pipete, take 18 grams of milk at a temperature of from 60° to 70°.

2. Add to this 17.5 c.c. of commercial sulphuric acid with a specific gravity (sp. gr.) of 1.82 to 1.83, and thoroughly mix the acid and milk by giving the bottles a gentle rotary motion.

4. Place the bottles in the tester and whirl for from four to five minutes, at a speed varying from 700 to 1,200 revolutions per minute, according to the diameter of the machine (700 revolutions per minute with a machine twenty inches in diameter).

5. Add hot water at a temperature not lower than 140° F. to float the fat into the neck of the bottle.

6. Rotate the machine again for about two minutes and take the readings before the fat cools. If troubled with burnt readings, add the water twice instead of all at once, filling the bottle just to the neck the first time, then turn the machine about a minute, fill to about the 8 per cent. mark the second time, and whirl for another minute.

7. Read the fat column at a temperature of from 120° to 140° F.

NOTES.

1. Always make sure that the pipettes and test bottles are clean before using.

2. Be very careful to measure the exact amount of milk for a test. A 17.6 c.c. pipette will deliver about 17.5 c.c. of milk. This measurement of milk of average quality will weigh about 18 grams.

3. A partially churned sample of milk may be prepared for sampling by heating it to about 110° F. and pouring it from one vessel to another, to mix it thoroughly. When it is thus prepared, take a sample as quickly as possible, and cool to about 60° F. before adding the acid.

4. In sampling frozen milk it is necessary that both the liquid and the frozen part be warmed and mixed thoroughly. The unfrozen part is richer in fat and solids than the frozen.

5. A sample of milk that has soured and thickened may be prepared for sampling by adding a small amount of some alkali to neutralize the lactic acid, and cause the curd to redissolve. A small amount of powdered concentrated lye is very suitable. Add just a small amount of lye at a time, and pour the milk from one vessel to another, to mix the lye with the milk, which causes the casein to become dissolved.

6. The amount of acid used must be varied to suit its strength. The right amount is being used when the fat presents a bright golden appearance. Acid that is much too strong or too weak should be discarded, as satisfactory results cannot be obtained from its use. Acid a little weak is to be preferred to very strong acid. Carboys or bottles containing acid should be kept well corked, to prevent the contents from becoming weakened by absorbing moisture from the atmosphere.

7. Avoid pouring the acid directly on the milk. The test bottle should be held at an angle so as to cause the acid to follow the side of the bottle and go directly underneath the milk. After the addition of the acid to the test bottle the milk and acid should be in two distinct layers without any charred matter between them. A thorough mixing by means of a gentle rotary motion should be given at once.

8. If using a hand tester in a room at a low temperature, it may be necessary to keep sufficient hot water in the machines to maintain a temperature of from 120° to 140° F. in the test bottles.

9. The water added to the test bottles should be soft or distilled. If hard water is used, add a little sulphuric acid (half an acid measure, or a little more to a gallon of water) to soften it; this will prevent foam above the fat.

10. If there are several readings to take, *always* set the samples in hot water (120° to 140° F.) extending to *the top of the fat* before reading.

11. It is well to use a pair of dividers or compasses for measuring the column of fat. The points of the dividers should be placed at the upper and lower limits of the fat column; then if one point be placed at the zero mark of the scale, the division at which the other point touches will show the percentage of fat in the sample tested.

12. Burnt or cloudy readings may be caused by :
 - (1) The use of too much or too strong acid.
 - (2) Allowing the acid to fall directly on the milk.
 - (3) Having the milk or acid at too high a temperature—the higher the temperature the less acid is required.
 - (4) Allowing a sample to stand too long after adding the acid, before mixing the milk and acid.
13. Light colored readings and floating particles of curd are usually due to :
 - (1) The use of too little or too weak acid.
 - (2) Having the milk or acid at too low a temperature—the lower the temperature of either, the more acid is required.
 - (3) Insufficient shaking of the bottles to unite the milk and acid thoroughly.
 - (4) Lack of required speed in time in whirling.
14. A convenient method of testing the accuracy of the graduation is to test the same milk in the different test bottles and compare the readings. A bottle that differs by more than .2 (2-10) in its reading from the rest should be discarded. As the capacity of that part of the neck over which the scale extends should be 2 c.c., the accuracy of the scale may be tested by filling the bottle to the bottom of the scale with water at the temperature of the room, and then adding 2 c.c. of water at the same temperature by means of a 2 c.c. pipette or a finely graduated burette.
15. Care and exactness in every detail are absolutely essential requisites for reliable results in milk testing. There is more to learn in *care* than in principle. Carelessness on the part of the operator has frequently thrown suspicion on the Babcock test.

COMPOSITE SAMPLES.

Whole milk creameries, and in many of the advanced cheese factories, the patron receives payment, not in proportion to the amount of milk, but in proportion to the butter or cheese value of the milk supplied by him. Such a system, of course, necessitates the use of the Babcock test. A test of the milk cannot be made daily; and to overcome this difficulty a small sample of the milk supplied by each patron is taken at each time of delivery and put into a bottle, called a composite sample bottle, which contains a small amount of some kind of preservative, such as bichromate of potash or corrosive sublimate. It is not advisable to use the latter alone, as it is quite poisonous, and imparts no color to the sample to indicate its presence. An excellent preservative is a mixture composed of about seven parts bichromate of potash to one part corrosive sublimate.

From what can be taken on a five cent piece to what can be taken on a ten cent piece will usually be found sufficient to preserve a sample for two weeks in summer and a month in fall and winter, when an ounce of milk is taken daily. The amount of preservatives required depends upon

the weather, the size of the samples, and the length of time over which the testing period extends. A Babcock test of the sample is made at the end of two weeks or a month; and if the daily sampling and the testing of the sample are carefully done, it gives the average quality of the milk supplied during the time over which the test extends.

The samples may be tested twice per month, but by keeping them in a fairly cool place satisfactory results can be obtained by testing but once a month.

NOTES ON COMPOSITE SAMPLING AND TESTING.

1. For holding composite samples, pint jars with long corks are preferable. Turned wooden corks are more satisfactory than porous corks.

2. The jars should be kept well corked, as the samples will dry on the surface and a tough skin, composed largely of cream, will be formed when exposed to the atmosphere in warm weather.

3. Paste a plainly written label on each patron's jar, fasten its edges down well, and give it at least two coatings of heavy shellac to prevent it from washing off when cleaning the bottles.

4. Add the preservative to the composite sample jars at the beginning of the testing period, and before any milk is added to them. It may be necessary to add a little extra preservative later on. Be guided by the color of the samples and how well they are keeping. An excess of preservative has a strong tendency to produce burnt readings.

5. The sample for the composite jar should be taken after the milk is poured into the weigh can. For this purpose an ounce or a half-ounce dipper is often used. A tube or milk "thief" and a drip from the conductor are also satisfactory means of obtaining a sample. When receiving milk that is partly frozen, guard against taking a sample from only the unfrozen portion.

6. Give the jar a gentle rotary motion each time a sample is taken, to mix with it the cream that has risen and also to incorporate the fresh sample with the part containing the preservative; and avoid shaking the jar, as shaking tends to churn the contents.

7. It is sometimes necessary to place the samples in a cool place each day when through using them.

8. To prepare composite samples for testing: Set the sample jars in warm water at about 110° F., to loosen the cream from the sides of the jars, and also to warm the samples to cause the cream that has risen to mix more readily with the milk. Mix well by pouring from one vessel to another—never by shaking. Should difficulty be experienced in getting a thorough solution, the addition of a small amount of potash will facilitate the operation.

When the composite samples for the Babcock test have been added to the test bottles, cool to about 60° F. before adding the acid. One of the points most frequently neglected and underestimated is attention to

temperatures. Sulphuric acid acts more strongly upon milk that is at a high temperature than upon milk at a lower temperature; also the higher the temperature the more the fat will expand and the greater the reading will be. Adopt some *constant* temperatures for each step of the work; the following have been found very satisfactory: About 60° for the milk when the acid is added, about 140° for the water added to the test bottles, and between 130° and 140° for the water into which the test bottles are set before a reading is taken. If you prefer different temperatures from those suggested, adopt them, but do not neglect to adopt *constant* temperatures.

It sometimes is an advantage to add the water to the test bottles at twice rather than all at once, filling each bottle just to the neck at first, and to about the 8 per cent. mark the second time. Whirl the tester for a minute after each addition of water.

9. Cost of testing composite samples: In a gallon of sulphuric acid there is enough for about 260 tests. Estimating the value of the acid to be 3½c. per pound, the cost of the acid for a single test would be one-quarter of a cent.

To find the average test of a number of samples: If the weights and tests of a number of different lots are fairly uniform, the average weight and test may be found by dividing the sum of the weights and tests by the number of lots, but when there is *no uniformity* in the different lots, the *true average* test can be obtained only by multiplying the total pounds of fat by 100 and dividing the product by the total pounds of milk. There is sometimes a wide difference between the mathematical average and the true average test of different lots.

TESTING CREAM.

The need of an accurate, simple, and speedy method of determining the butter value of cream has become more and more urgent with the general adoption of the Cream Collecting System of Creamery management.

The Oil Test has been used for many years with a measure of success, but it may no longer be regarded as a reliable test for creamery work.

Its chief weak points and objections are as follows:

1. The readings or tests vary with the churnability of the samples. For example, a sweet sample, low in fat, will rarely yield an exhaustive separation of clear oil or fat. A low reading or poor test is usually obtained from such a sample.
2. The amount of labor involved in properly caring for the tests.
3. The machines used for the churning process are usually very noisy and often troublesome.

The Babcock test for cream has stood the test of several years' criticism and experience, and may be regarded as a simple, accurate, and satisfactory test for creamery work.

Cream test-bottles are graduated to read 30, 40, or 50 per cent. fat, and differ from whole milk bottles only in the diameter of the neck. The intermediate size is usually the most satisfactory for factory work. The scale on the neck of the ordinary milk or cream test bottle is graduated to read directly the per cent. of fat, only when 18 grams are used in the test, i.e., the fat extending over one of the larger divisions of the scale weighs *one per cent.*, or the one-hundredth part of 18 grams. This fact will explain the various rules for determining the per cent. of fat when 18 grams cannot be used in a test—as in the case of cream and cheese, in which the per cent. of fat is high.

RULE. To find the per cent. of fat when less than 18 grams have been used; multiply the reading obtained by 18 and divide by the number of grams used.

This weight may be most accurately obtained by means of a delicate balance, but in the hands of the average dairyman it is a question if the use of a balance would result in greater accuracy than a pipette for sampling cream in a normal condition. The specific gravity of average cream (25 to 30 per cent.) being nearly *one*, the weight delivered by an 18 c.c. pipette would be approximately the required amount, viz., 18 grams.

During the process of cream ripening, however, more or less gas is usually formed which tends to reduce the specific gravity and thus lessen the weight of a given volume of the cream. It will thus be seen that sour cream sampled with a pipette would tend to give readings slightly lower than sweet cream. The difference in the test would scarcely be perceptible at a low per cent. of acid, but would be more marked at a high, sharp, acid condition.

The use of a pipette for sampling in creamery work places a slight premium on sweet cream, thus affording a pertinent means of discriminating against overripe and otherwise objectionable grades of cream.

A sample containing an unusual amount of air or gas may be more accurately sampled if warmed to a temperature of about 110° F., and, after the necessary mixing, cooled to about 60° F.

NOTES.

1. A pipette graduated to read both 17.6 c.c. and 18 c.c. is a convenience, the former measurement being required for whole milk, skim milk, buttermilk, and whey, and the latter for cream.

2. When sampling viscous cream the pipette should be rinsed with about one-third measure of warm water, which should be added to the test bottle.

3. The addition of a small amount of caustic soda or concentrated lye to viscous or lumpy samples renders sampling more speedy and accurate.

4. Composite samples of cream may be cared for and treated in the same manner as outlined for milk under the heading, "Composite Samples." Page 18.

5. Sample jars should be kept well corked during warm weather to prevent evaporation. Carelessness in this matter may allow the samples to give off sufficient moisture to cause the test to read from 1 to 10 per cent. too high.

6. No specific measurements of sulphuric acid can be given for cream, as some samples require more than others. The proper amount is being used when the fat column presents a clear golden color. It is well to use the minimum amount at first, and if a light shade is produced at the time of mixing, more may be added.

7. If troubled with cloudy or muddy readings, the addition of a few cubic centimeters of water to a sample before adding the acid is a good practice.

8. Experiments prove that after mixing the cream and acid the necessary hot water may be added before whirling.

9. Under favorable conditions, composite cream samples may be tested monthly. Under conditions where difficulty is experienced in preserving the samples it may be well to test semi-monthly.

10. As the Babcock test is based on weight, it is necessary to either weigh the cream or estimate the weight from the number of creamery inches. According to experiments conducted at the Ontario Agricultural College, an inch of average cream in a pail 12 inches in diameter will weigh 4.1 pounds. Thus, if it were found more convenient to measure the cream than to weigh it, the weight could be determined by multiplying the number of inches by 4.1. The number of pounds of cream furnished by a patron during a month, multiplied by the test, on the per cent. fat, and divided by 100 will give the number of pounds of fat which the cream contained.

11. A spring balance is a convenience when it is necessary for collectors to weigh cream at the farm. The use of these scales is allowable only when they pass the necessary Government inspection.

THE OIL TEST.

This means of ascertaining the butter value of cream is still employed in a few sections, and is simply a churning process.

The cream collector is supplied with a pail 12 inches in diameter in which the depth of cream supplied by the patrons should be carefully *measured*. After thoroughly mixing the cream the collector should take a representative sample, filling the test tubes carefully to the mark, which should be five inches from the bottom.

TO MAKE AN OIL TEST. Upon their arrival at the creamery, place the samples in a warm place, as over the boiler, and leave over night to ripen thoroughly. *They will not churn properly unless well ripened.*

The next morning place the samples in water at a temperature of about 90°, and as soon as the cream will flow freely from one end of the tube to the other, place in the oil test churn and begin the churning. Should the cream at any time cool and thicken, place the samples in warm

water to liquefy the cream again. Continue churning until there is evidence of a clear separation of the fat; then place the samples in hot water, at a temperature of from 160° to 170° , for from fifteen to twenty minutes.

If the separation be complete, the fat will be clear and yellow, and there will be three distinct columns with sharp lines of division between them, viz., a column of clear fat on top, one of whey next, and one of curdy matter at the bottom. If there be not a clear separation, cool to about 90° , churn again and proceed as before.

TO TAKE A READING. There is a chart prepared for the purpose. Placing the bottom in an upright position on the "base line" of the chart, move it along until, when looking by the right side of the bottle, the top of the column of fat comes even with the uppermost slanting line on the chart. Next, still looking by the right side of the bottle, observe the line to which the bottom of the fat comes; the number on this line gives the reading.

A small rule made specially for the purpose is more convenient than a chart. This, however, will give a correct reading only when the test-tubes have been filled precisely to the mark. The chart consists of a sliding scale, and gives the proportion of oil regardless of the depth of cream taken or the diameter of the test-tubes.

Sometimes the fat, though clear, is somewhat open. In such cases, or when the fat is not clear, allow the samples to become cold, and then place in water at a temperature of about 120° F. before taking a reading. About 120° is a very suitable temperature at which to take readings.

MEANING OF THE READING. Cream that gives a reading of 100 in the oil test will make one pound of butter for every inch of such cream in a cream pail 12 inches in diameter; cream testing 120 will make 1.20 pounds of butter per inch. To find the pounds of butter, multiply the number of inches by the reading and divide by 100.

THEORY OF THE TEST. A standard or creamery inch is one inch of cream (in a 12 inch pail) testing 100.

One inch, therefore, contains 113 cubic inches. One pound of butter contains about 25 cubic inches of butter oil, which is 22 per cent. of 113. Therefore, any cream which will yield 22 per cent. of its volume in butter oil will yield one pound of butter per inch. Tubes filled to the depth of 5 inches with cream which gives 1.1 inches of butter oil will yield one pound per inch, as 1.1 is 22 per cent. of 5.

A reading of 100 by the oil test would, therefore, theoretically, be equal to 22 per cent. of fat.

The relation between the oil test and percentage of fat or Babcock test may be viewed from the Babcock side as follows: The overrun in collecting creameries may vary from 12 to 13 per cent. to as high as about 18 per cent. Then 100 pounds fat would probably yield about 115 pounds butter.

1 pound of butter would thus be obtained from 100/115 pounds fat.
1 inch of cream weighs 4.1 pounds.

Therefore in order to yield 1 pound butter per inch,

4.1 pounds cream must contain $\frac{100}{115}$ pounds fat.

1 pound cream must contain $\frac{100}{115}$ divided by 4.1 pounds fat ($\frac{100}{115} \div 4.1$).

100 pounds cream must contain $\frac{100}{115} \times \frac{1}{4.1} \times \frac{100}{1}$

Equal to 21.2 pounds fat.

According to experiments conducted at the Ontario Agricultural College Dairy School, the actual percentage of fat in cream yielding 1 pound of butter per inch is 21.1 per cent.

The relation between the value of a pound of fat and a pound of butter may be found to vary somewhat according to the percentage of overrun obtained.

With an average overrun of 15 per cent. and butter worth 17 cents per pound, the value of a pound of fat may be estimated as follows: A 15 per cent. overrun would prove 100 pounds fat to yield 115 pounds butter; 115 pounds butter at 17 cents equals \$19.55; then 100 pounds of fat must be of the same value—\$19.55. Therefore, 1 pound fat must be worth 19.55 cents. If fat were worth 17 cents a pound, the value of 1 pound could be estimated as follows:

100 pounds fat at 17 cents equals \$17.00.

100 pounds fat should yield about 115 pounds butter, therefore

115 pounds butter are worth \$17.00.

1 pound butter is worth \$17 divided by 115 equals 14.78 cents.

With an average overrun and butter worth from 16 to 18 cents per pound the difference between the value of a pound of fat and a pound of butter would be from 2 to $2\frac{1}{2}$ cents per pound.

SKIM-MILK, BUTTERMILK, AND WHEY.

As the percentage of fat in skim-milk, buttermilk and whey is so small, the best method of testing these is by the use of the double-neck skim-milk bottle.

The usual amount of milk or whey is taken and the test is made in the usual way. Very fine readings can be taken, as a very small amount of fat will extend over quite a length in the small neck. Considerable controversy has taken place from time to time among the leading authorities as to how each division on the scale should be read, but it has been demonstrated that reading the first divisions as .1 (1-10) and each succeeding division as .05 ($\frac{1}{2}$ of 1-10 equals 1-20 or .05) gives results comparing quite favorably with gravimetric analysis.

Slightly more than 17.5 c.c. of acid may be used to advantage when testing skim-milk; it is also advisable to increase the speed of the tester or the length of time it is whirled.

The fat column in a double-necked bottle may be raised to any desired point on the scale by gently pressing with the finger on the mouth of the large neck.

It is not necessary to use quite the full amount of acid when testing whey.

The ordinary milk bottle is not suitable for testing skim-milk, butter-milk, or whey, as it is almost impossible to make an accurate reading of such a small amount of fat when it is extended over a broad surface.

THE LACTOMETER AND THE DETECTION OF ADULTERATIONS IN MILK.

The lactometer is an instrument used to determine the *specific gravity* of milk. The term specific gravity means the weight of a certain volume of any substance compared with the weight of the same volume of pure water at a standard temperature.

There are different kinds of lactometers, but the Quevenne is the most suitable for milk-testing. By means of it we can determine rapidly the relative weight of milk and water.

The Quevenne lactometer is standardized at a temperature of 60°; if the milk to be tested varies from this, corrections may be made according to the following rule: For each degree in temperature *above* 60, add $.1 \left(\frac{1}{10} \right)$ to the lactometer reading, and for each degree *below* 60, subtract $.1 \left(\frac{1}{10} \right)$ from the lactometer reading. This rule is practically correct, if the temperature is kept within a range of from 50° to 70°. It can be readily recalled when we remember that the density of milk *increases* with a *reduction* of temperature and decreases with a rise in temperature. The scale on the lactometer is graduated from 15 to 40, and indicates a specific gravity of from 1.015 to 1.040.

Note. The correct lactometer reading (or L.R. at 60° F.) $+1,000 \div$ 1,000 indicates the specific gravity.

The lactometer reading of whole milk usually ranges from 29 to 34, although it may fall as low as 27, or go as high as 35. The lactometer reading of skim-milk varies from 33 to 38. The reading should be taken soon after placing the instrument in the milk; if cream be allowed to rise on the milk, the reading will be too high, as the bulb of the lactometer will be floating in partially skimmed milk. Milk should be cooled and allowed to stand some time (one to three hours) after being milked before taking the lactometer reading. Otherwise the readings will be too low.

The composition of milk is about as follows:

Fat	3.6	per cent.	
Casein	2.5	"	} 8.9 solids not fat.
Albumen	.7	"	
Sugar	5.0	"	
Ash	.7	"	
Water	87.5	"	

100.00

It is the solids-not-fat in milk that cause its specific gravity to exceed that of water, and consequently its lactometer reading to be greater than that of water.

A number of different formulas have been prepared for the calculation of milk solids when the lactometer reading and percentage of fat are known. As the percentage of solids-not-fat increases .25 per cent. for each lactometer degree and .2 per cent. for each per cent. of fat, the following formula has been very generally adopted: ($\frac{1}{4} + .2$ fat. To find the *total solids* in a sample of milk, add $\frac{1}{4}$ of the lactometer reading to 1.2 times the per cent. of fat.)

The following rule is sufficiently accurate for practical purposes and has simplicity to recommend it: To determine the per cent. S.N.F., add the correct lactometer reading and per cent. fat together, and divide by 4.

$$\frac{L+F}{4} = \% \text{ S.N.F.}$$

ADULTERATIONS.

By the use of the Babcock test in conjunction with the lactometer, we are enabled to determine both the nature and the extent of an adulteration.

The percentage of fat in milk varies and can also be influenced by skimming, therefore the lactometer alone is of little use in determining adulterations. The solids-not-fat are fairly constant and thus afford a means of detecting adulterations.

Watered Milk. To find the per cent. of pure milk in a watered sample, multiply the per cent. S.N.F. in it by 100 and divide by the per cent. S.N.F. in the pure milk. This subtracted from 100 will give the per cent. of extraneous water in the watered sample. To take an example:

The per cent. of solids-not-fat in a sample of pure milk is 9; but after being watered the per cent. of solids-not-fat in the watered sample is 7.2. Find the per cent. of pure milk in the watered sample.

Per cent. of pure milk in watered sample, $\frac{7.2 \times 100}{9} = 80$ per cent.

Per cent. of extraneous water = $100 - 80 = 20$ per cent.

Note. When a sample of pure milk cannot be obtained, use 8.5 in the early part of the season, and 9 in the later part, for the per cent. S.N.F. in pure milk.

The per cent. of *water added to the pure milk* may be estimated as follows: The per cent. S.N.F. in a pure sample, multiplied by 100, divided by the per cent. S.N.F. in the watered sample, less 100. The above may be worked out as follows:

$\frac{9 \times 100 - 100}{7.2}$ equals 25 per cent. water added, or

To 80 lbs. pure milk, 20 lbs. water were added, then to
1 lb. pure milk, $\frac{20}{80}$ lbs. water were added.

To 100 lbs “ $\frac{20}{80} \times \frac{100}{1}$ lbs. water were added,
equals 25 lbs. water added to 100 lbs. milk, or 25 per cent.

NOTES.

1. Have the temperature of the milk uniform throughout, and as near 60° as possible when taking a lactometer reading.
2. Always mix the milk well before taking a lactometer reading.
3. Do not have milk on the upper part of the stem of the lactometer when reading, as this weighs the lactometer down and causes the reading to be too low.
4. Have the lactometer free from the side of the vessel, and perfectly still when taking a reading.
5. A high lactometer reading accompanied by a low per cent. of fat indicates skimming, e.g., L. equals 34, F. equals 2.4.
6. A low lactometer reading accompanied by a low per cent. of fat is indicative of watering, e.g., L. equals 22, F. equals 2.4.
7. A normal lactometer reading with a very low per cent. of fat indicates both watering and skimming. Also, if the lactometer reading of a sample of milk be low, yet not so low accordingly as the per cent. of fat, this is indicative of both watering and skimming. Both of the following indicate watering and skimming; L. equals 31, F. equals 2; L. equals 26, F. equals 1.8.

TESTING CHEESE FOR FAT.

The fat content of cheese may be obtained by weighing from 2 to 5 grams, adding sufficient water to make up 18 grams and testing in the usual way.

$\frac{\text{Reading} \times 18}{\text{grams used}}$ equals per cent. of fat in sample tested.

Accurate and satisfactory results in testing may be obtained only by exercising the greatest care at every step in the work, coupled with sound judgment and experience.

HINTS ON THE CARE OF MILK FOR CREAMERIES AND CHEESE FACTORIES, AND CANADIAN CHEDDAR CHEESEMAKING.

BY W. WADDELL AND A. MCKAY.

Milk is the raw material from which the cheese or buttermaker manufactures a valuable and concentrated food product. It is a perishable article and very susceptible to contamination; hence it is important that great care be taken to keep it sweet and free from any undesirable germs or taints. Milk should be supplied only from cows in good health furnished with an abundance of wholesome food, pure water, and having free access to salt at all times.

Cows giving milk should not be allowed to eat turnips, rape, foul weeds, musty or decayed food, or anything that will impart an objection-

able flavor to the product, as injury to the milk from any cause results in a positive loss to the producer.

It is very important that there be no dust or bad odors in the stable at the time of milking, as the thin stream of milk passing from the teat to the pail will collect a large amount of any impurities that may be in the atmosphere. Before commencing to milk the udder and flank of the cow should be brushed or wiped with a damp cloth to remove loose hairs or fine particles of dust or filth. The milker should be clean, kind and sympathetic and free from any contagious disease. Milking should be done quickly and as exhaustively as possible. Immediately after milking remove the milk to a clean, pure atmosphere and strain thoroughly to remove fine particles of dirt, as, no matter how carefully the milking is done there is likely to be some dirt in the milk, and this should be removed as quickly as possible. Special provision should be made for cooling the milk quickly to at least 65° F., and for keeping it at that temperature over night, and to 50° and holding it at that temperature if keeping the milk over Sunday. This may be accomplished by providing a tank large enough to contain cans holding at least two milkings and surrounding them with cold water. The milk should be stirred occasionally while cooling. A wire handled dipper should be provided for this purpose. Provision must be made for changing the water used to keep down the temperature. Ice is almost a necessity for keeping Saturday night's or Sunday's milk. The warm milk should in no case be mixed with that already cooled, and where possible send it to the factory in separate cans. If this is not done the morning's milk should be cooled before mixing with the evening's milk.

When purchasing tinware examine the seams carefully and see that all joints are well soldered so as to facilitate cleaning. Wash and cleanse thoroughly all utensils used in handling milk. First rinse them with warm water; then wash well with water at a temperature of 110° to 120° and then scald or steam. Do not wipe with a cloth, but place to drain where they will get plenty of sunlight and pure air. Use a brush in preference to a cloth for washing tinware. A free use of washing soda will be found beneficial, but soap should not be used on milk cans or pails. The occasional scouring with salt will serve a good purpose. Wooden pails should never be used for milking.

The whole secret of keeping milk in good condition is cleanliness, and low temperature, and under no condition should chemicals be used for preserving milk.

THE CURD TEST.

Provide tin or porcelain cups sufficient in number to test the milk of at least half the number of patrons supplying milk to the factory. A convenient size would be two inches in diameter and four inches deep. Each cup should be plainly numbered. Provide a box of tin or galvanized iron with a neat fitting cover large enough to hold the cups. For convenience this box should have both steam and water connections. In

taking samples for making the test place the number of the cup opposite the patron's name from whose milk the sample has been taken. When the samples have all been taken, place them in the box already described, adding water to the depth of the milk in the cups; raise the temperature to 86° F.

Set the samples, by using one dram of a dilute rennet made of a strength of one part rennet to twenty-four of water. Stir in the rennet with a knife having a solid metal handle, being careful to sterilize the knife between the stirring of each sample so as not to contaminate one sample with flavors from another. When firm enough cut with the same knife, using the same precautions to sterilize between the cutting of each sample. Raise the temperature gradually to 98° F. and handle the samples as nearly like the milk and curd in the vat as possible. In two and a half or three hours after setting pour off the whey. Keep up the temperature for three or four hours after this, and examine the samples occasionally for flavor by smelling and the texture by cutting with a sharp knife.

If looking for bitter flavor, and the milk is in a sweet condition, it may be advisable to add a few drops of culture to the samples before setting, as this flavor is rarely detected without the presence of acid.

This test is particularly valuable in detecting flavors which develop in the curd, but cannot be detected in the ordinary way when milk is delivered. It is also valuable for convincing patrons, who may doubt that the flavor of their milk is as bad as represented by the cheesemaker, as it is possible to have them see and smell the curd made from each patron's milk as delivered at the factory.

THE PREPARATION AND USE OF A CULTURE.

That there has been such a strong prejudice against the use of cultures in the minds of some of our best cheese buyers is not to be wondered at when we consider the careless slipshod methods in which some makers prepare cultures, and the unrestricted use of them by others, regardless of the ripeness of the milk, or the acidity and flavor of the culture. The flavor of the culture used will largely determine the flavor of the cheese or butter made. Therefore, the need of full and exact knowledge of the proper method of preparing and using cultures is manifest.

First provide suitable cans. It is better to have a duplicate set if possible. Cans similar to the ordinary shot-gun cans which are eight inches in diameter and twenty inches deep are quite suitable. When the milk is in small lots it can be more readily heated and cooled than if kept in larger quantities. For convenience in heating and cooling a special box or tank large enough to hold the cans containing the culture for one day's use should be provided. This should have steam and cold water connections. The cans may be left in this box so as not to be influenced by the outside temperature.

In starting a culture it is advisable to use a commercial, pure culture. These may be obtained from our Bacteriological department or from any

of the dairy supply houses. Empty the mother culture into a quart of cooled pasteurized milk, and allow it to stand at a temperature of 75° F. until coagulation takes place. Two per cent. of this culture may then be added to pasteurized milk at a temperature of 70° for the next propagation.

After selecting the milk for culture, heat to a temperature of 185°, stirring occasionally while heating. Allow it to stand at this temperature for 20 or 30 minutes, then cool rapidly to a temperature of 65° or 70° F. To this milk add sufficient of the culture already prepared to develop an acidity of not more than .7 at the time the culture is required for use.

If the culture is to be kept for more than 24 hours, it is advisable to use a lower temperature—60° F. or under. Aim to produce the same acidity from day to day. Before using, remove one or two inches of the milk from the surface of the can, as the surface is more liable to contamination from outside sources; break up the remainder by stirring well in the can. At this time take out a small quantity to propagate culture for next day. A glass sealer should be provided for this purpose.

The indications of a good culture are as follows: The whole mass is firmly coagulated, no liquid is found on top, and it has a milk acid flavor pleasant to taste and smell.

A culture may be used to advantage when the milk is maturing slowly or when it is tainted or gassy.

One-half of one per cent. is the greatest quantity which should be used at any time, and this quantity should be used only when the milk is known to be in a sweet condition.

Milk should be set slightly sweeter when culture is used. With gassy milk its use is especially beneficial. Culture with bad flavor or with too high an acidity should not be used.

A wire-handled dipper is preferable for stirring milk for culture, and all utensils must be thoroughly cleaned and sterilized after each time of using.

CHEESEMAKING.

...

NEED FOR IMPROVEMENT.

That there are some improvements being made in our factory buildings and equipment and in the sanitary condition in which they are kept cannot be denied, but it is also true that there is room for great improvement in this direction. We still have some factories that are not up to date, and are wholly unfit for handling in a sanitary condition so delicate a food product as milk. We have also some makers who do not put forth the effort necessary for keeping their factories in a proper condition. The time has come when it is necessary that all interested in the cheese business join hands to have these hindrances to the best quality of our goods

speedily removed. The training which our cheesemakers receive at the dairy schools should have a marked tendency to improve the appearance of the maker, and also the inside and surroundings of his factory. It has also been proved beyond a doubt that to make the finest quality of cheese we must have our curing-rooms so constructed that an even and comparatively low temperature can be maintained. This should not be allowed to exceed 65° in the hottest weather.

MILK FOR CHEESE-MAKING.

In the manufacture of cheese the first and most important matter is to have the milk delivered at the factory clean, sweet, and of good flavor. How this may best be accomplished is a subject that should engage the attention of all interested in the dairy business. We would suggest that our instructors spend as much time as possible among the patrons, and with the assistance of our chemists and bacteriologists find out the causes and remedies for so much bad-flavored milk and cheese. We would urge upon makers the necessity of rejecting at the weigh stand all milk which is not in a fit condition for the manufacture of first-class cheese, as receiving milk of this kind is a serious injustice to patrons supplying milk of good quality.

TESTING FOR RIPENESS.

This may be done for setting, with the acidimeter or rennet test. Good results may be obtained by the use of either test. No definite degree of acidity can be laid down as a rule to go by. The proper rule is to set at the degree of acidity that will give the best results later in the process, or will allow the curd to remain in the whey until properly cooked, which will usually take from $2\frac{3}{4}$ hours to 3 hours from the time of setting the vat to the time of dipping the curd with the right amount of acid developed. This will be found to be slightly less than the acidity of the milk at setting as shown by the acidimeter.

In making early spring cheese it is usually necessary to make a quick-curing cheese in order to reach an early market.

To make this class of cheese it is advisable to use a large quantity of rennet and a small amount of salt, as this hastens the ripening process and overcomes the tendency in milk at this season to make a dry, harsh cheese due to the low per cent. of butter fat in the milk. Heat the milk to 86° and stir slowly while heating.

If using the acidimeter and making colored cheese, the acidity should be taken before adding the color to the milk, as it is more difficult to detect the neutral point with color added. Another point to note carefully when using the acidimeter for setting, is the effect of the presence of rain water in the milk. When the milk is diluted, less milk is taken in the

sample, and will show a lesser degree of acidity than is contained in the milk to the extent of the percentage of dilution. If color is used it should be thoroughly mixed with the milk before the rennet is added, using one to one and a half ounces of color to 1,000 pounds milk. Add color in amount as the market demands it.

When the desired acidity is obtained add the rennet, using four to five ounces per 1,000 pounds milk or enough to coagulate the milk, fit to cut in 15 to 20 minutes. Commence to cut early, using the horizontal knife, first cutting slowly lengthwise of the vat, then with the perpendicular knife cut crosswise, and afterwards lengthwise, which will be sufficient for normal milk. Commence stirring at once with agitators or with a McPherson rake. Stir carefully for 10 to 15 minutes before applying heat, and be careful to have the curd all free from the bottom and sides of the vat before turning on the steam. Curd should be handled carefully and in such a manner that the cubes will not be broken or allowed to mat together, as rough handling or breaking of the curd causes a serious loss in both quantity and quality. Heat to the cooking temperature of about 98° F. in 1½ hours from the time of setting. If using agitators, take them out in 10 or 15 minutes after the cooking temperature is reached. Remove at least half the whey and keep the curd stirred sufficiently to prevent it matting. Acid usually develops very rapidly in the spring; therefore it is necessary to be prepared to remove the whey quickly when enough acid has developed, which may be from .17 to .2 as shown by the acidimeter. Be careful to stir the curd dry. Curd must be well cooked and stirred dry if a fine cheese is expected. Leave the curd about eight inches deep in the curd sink. When it is well matted together cut into strips six to eight inches wide and turn upside down, and in about 15 minutes turn again and pile two deep. Continue turning every 15 minutes until the curd is ready to mill. When the curd is well matted and flaky, and shows .7 to .8 per cent. of acid it should be milled, and then well stirred afterwards. The stirring should be repeated often enough to prevent the curd matting until ready to salt. This will be when the curd has mellowed down nicely and shows from 1 to 1.2 per cent. acid. Stir the curd well before adding the salt to give the cheese good body and improve the flavor and texture. Salt at the rate of 1½ to 2 pounds of salt to 1,000 pounds milk. It is important that the temperature of the curd from dipping to milling be about 94°. After milling, allow the curd to cool gradually to about 85° when ready to salt. Put to press at a temperature of 82° to 84°. Weigh the curds into the hoops; tighten the press gradually and leave the cheese 45 to 60 minutes before taking out to dress. When dressing use plenty of clear hot water, and what are commonly called skirts. These cloths help to make a good rind on the cheese and keep them clean and cause the cheese to come out of the hoop more readily. Turn all cheese in the hoops every morning and allow no cheese to be taken to the curing-room that are crooked, have wrinkles in the bandage, or rough edges.

SUMMER CHEESE.

In making summer cheese one ounce of color per 1,000 pounds of milk is usually enough, but this may be varied according to the requirements of the market. Use from three to three and one-half ounces of rennet extract per 1,000 pounds of milk, or sufficient to coagulate the milk fit to cut in 25 to 30 minutes. The cutting and cooking of the curd is the same as given for spring cheese.

It may be necessary in some cases to raise the cooking temperature slightly higher, or to about 100 degrees, shortly after normal cooking temperature is reached. The whey should be partially drawn off and the curd well stirred by hand or with a rake to insure thorough cooking. The acidity should be allowed to develop to such a point that is found from day to day to give best results in the working of the curd later in the process, aiming to have the curd with good body, well matted and in a flaky condition when ready to mill. At this time it should have an acidity of .75 to .85 in $1\frac{3}{4}$ to 2 hours from the time of dipping. Curd should be well stirred after milling. Care must be taken not to salt the curd too soon as open cheese may be the result. Curd should be well ripened, stirred and aired thoroughly and cooled to a temperature of 85° before salting. Use from 2 to $2\frac{1}{2}$ pounds of salt to 1,000 pounds of milk.

FALL CHEESE.

In making fall cheese it is a mistake to use too much culture, or to ripen the milk too much, giving the cheese the appearance of having been made from over-ripe milk, which is very objectionable. Rather use a smaller amount of culture, not more than $\frac{1}{4}$ of 1 per cent., and add it to the milk as early as possible, then allow the milk to ripen. Always heat the milk to at least the temperature of the culture before the culture is added. Set slightly sweeter than usual, as we are able to work closer to the sweet line all the way through when culture is used.

GASSY MILK.

The presence of gas in milk retards the development of acid, and as acid is necessary in the manufacture of cheese we should make the conditions as favorable for its development as possible without injury to the body of the curd. To do this, use $\frac{1}{4}$ to $\frac{1}{2}$ per cent. of good culture, ripen slightly lower for setting than for normal milk, when cutting aim to have the cubes even in size and as large as possible, allow the acid to develop slightly farther before applying heat, stir carefully, and heat slowly, aiming to have the curd in normal condition at dipping. Use the same cooking temperature and the same acid for dipping as with a normal curd. A gassy curd does not require so much stirring, as the moisture leaves the curd more readily. Cut and turn as usual and pile according to the body of the curd. Mill as soon as the curd is well matted, and the acidity has

developed to .8 to .85 per cent. About half way between milling and salting, commence piling the curd, allow it to stand for 15 to 20 minutes, then spread out, stir well and pile again. Continue to do this until the curd is nice and mellow. Give plenty of fresh air before salting. Use a normal amount of salt, and put to press at a temperature of 80° if possible.

OVER-RIPE MILK.

This class of milk should be avoided, as the loss is too great, even when handled in the best possible way. The heat should not be applied till milk enough is in sight to fill the vat, and then heat as quickly as possible to 82° or 83°, and after testing for acidity, set at these temperatures, using one ounce extra of rennet per 1,000 pounds milk. Stir for about two minutes. Commence cutting early and cut fine, using the horizontal knife for the fourth cutting, cutting lengthwise of the vat. Where possible use a finer knife than usual. Cook quickly and if necessary raise the temperature two or three degrees higher than for normal milk. Run off the whey as soon as possible, and stir the curd well in the small amount of whey before dipping, so as to have the curd well firmed before sufficient acid is developed. Dip with slightly less acid where possible. Stir dry, and if the curd has been well handled, treat the same as a normal curd. If the curd is not well cooked and the moisture properly expelled from it, mill early and ripen well before salting.

RIPENING OR CURING CHEESE.

The ripening or curing of cheese is one of the most important points in the whole process, as no matter how well a cheese is made if the curing is not properly done the quality cannot be the finest. Hence it is a necessity to provide a room where the temperature can be controlled at all times. It is important that some means be provided to control the moisture in the room to prevent the growth of mould which occurs when too much moisture is present. An excessive shrinkage takes place if there is too little moisture in the room. This may be accomplished by building an ice chamber in connection with the curing-room and having a free circulation of air over the ice. This cools the air and causes a deposit of the moisture on the ice.

In putting the cheese into the curing-room, place them straight and evenly on the shelves and turn them every morning except Sunday. Keep the room well swept and looking neat and tidy.

Use good strong cheese boxes. Have them dry and made to fit the cheese neatly. Put two scale boards on each end, weigh carefully and stencil the weights plainly on the boxes. Load the cheese on clean wagons and have canvas covers to protect them from rain and heat while on the way to the station.

SEPARATORS AND THE SEPARATION OF MILK.

BY R. W. STRATTON.

In dealing with this subject, general directions only can be given. Space will not permit giving detailed directions for the different makes of separators. A book of directions is furnished with each new separator sent out, and the specific instructions contained therein should be strictly followed unless you know of something better, which you have proven to be so by practice, not theory. Separators may be divided into two classes—the steam or turbine, and the belt separator.

TURBINE SEPARATOR.

In setting it up, a solid foundation should be provided. It does not matter how solid a wooden floor is, it will vibrate more or less from the running of a churn or other machinery. With a stone, brick, or cement foundation a separator is independent of any vibration from other machinery and will run much better, and for a longer time. If setting the separator on a cement floor probably the most permanent method of fastening it down would be as follows: First mark the exact location for the holes. With a square draw a line through the centre where the holes should be, then drill the cement to the desired depth (6 to 7 inches). To do this a common cold-chisel may be used providing the bit is wide enough for the body of the chisel, though a pointed chisel for this purpose is preferable. The dust may be removed from the hole while drilling by a small bellows, or blowing through a small rubber or glass tube. Have the bolt head somewhat rounded and place the bolt in the hole with the threaded end up, making sure to have it perpendicular and in line, and the necessary height above the floor, then pour melted lead in the hole around the bolt. If a method is desired whereby the bolts can be removed from the floor, drill holes as above, plug with wood, bore with a bit at least $\frac{1}{8}$ of an inch smaller than the lag screws used and fasten down with lag screws. Another method whereby separators may be changed without drilling new holes is to drill the holes in the cement nearer to the centre than any separator will be likely to require, fasten a 2 inch by 4 inch piece of wood to the floor and bolt the separator to it.

In putting down a cement floor to be used for separators, it is well to have a pier built about two inches higher than the floor and about the size of the separator base. This tends to prevent dirt from lodging under the separator when scrubbing the floor.

If a stone or brick pier (bricks are neatest) has to be built, the nature of the soil will determine the depth to excavate, and the size of the frame or base of the separator will determine the length and breadth. The exact specifications are given in the book of instructions furnished with the separator.

Place the separator in position, being careful to have the separator frame perfectly level every way. Determine this by placing the spirit level upon the planed top of the frame.

The pipe to convey the steam to the separator may be the same size as the fittings of the separator, provided the distance from the boiler is not over twenty-five feet. When there is more than this distance the size of the pipe should be one-quarter inch larger for every twenty-five feet of piping, to overcome friction and condensation of steam.

Exhaust pipes are usually made of galvanized iron, and should never be reduced in size at any point, smaller than the outlet on the separator, and should be put up as straight as possible to convey the steam from the separator. It may be carried out at the side of the building. In either case, a piece extending upwards should be put up to cause a draught. Placing the exhaust pipe out through the roof is preferable when the surroundings will permit it. Have the pipe long enough to be higher than any part of the roof, in order that the draught may not be interfered with by change of wind. A drain pipe must be provided in any case at the lowest point on the pipe, to allow water to escape readily. If this should be in the making-room, a trap to prevent annoyance from escaping steam may be put on the drain pipe.

BELT SEPARATORS.

The directions given for the foundation of a turbine will apply to this. First place the intermediate or jack in position. This should be at an angle of at least 45 degrees in front or behind the driving shaft. Level it by placing a level perpendicularly on the planed rim of the separator pulley of the intermediate. Be sure to have the shaft of the intermediate parallel with the driving shaft.

The pulley provided for the driving shaft should be of sufficient width to allow the belt to be shifted from the tight to the loose pulley of the intermediate, and of the proper size to give the exact speed required. Next place the frame of the separator in position. Level it in all directions by placing the level on the planed top of the frame. Line the separator with the intermediate, so that looking from the intermediate the right hand edge of the small pulley of the separator is in line with the right side of the large pulley of the intermediate, having the vertical centre line of the spindle level with the underside of the intermediate pulley.

The separator bowl should revolve to the right, or with the sun, the same as the hands on a watch. The intermediate should run from the separator, so as to place the draw belt on the upper side of the intermediate pulley, with a view to remove some of the weight of the bowl from the foot-step bearing when the separator is running. If an idler or belt-tightener is used, always place it on the "return" side of the belt—*never* on the "draw" side.

Do not use the belt tightener any more than is absolutely necessary, as it shortens the life of the belt very materially. It would be an improvement if the intermediate could be adjusted to suit the stretching of the separator belt.

Wipe all the bearings well with a cloth, to remove all grit and dust. A little coal oil upon the cloth will be found helpful where any coating of dried oil is met with. See that all oil tubes are clear and free to feed oil. Wash the bowl and all parts that the milk comes in contact with. If everything has been properly attended to as directed it is ready to start. If a turbine, turn on steam very gradually to allow the water to get out of the steam pipes, when the required amount of steam may be turned on. When speed has been reached, start the feed of milk.

If a belt machine, and only one in use, put all belts in position, and start the engine slowly, allowing the speed to increase gradually. If more than one separator is used, it is better to start the engine at full speed, then shift the belt from the loose to the tight pulley after starting the separator by pulling the belt with the hand until the bowl has attained some speed. Then shift the belt from the loose pulley part way on to the tight pulley, moving it at intervals until on full. From 6 to 10 minutes should be required to get up speed. Full speed is ascertained by means of speed indicators. A 100 notch wheel should be counted for one minute, and a 50 notch wheel for one-half a minute, in order to know the number of hundred revolutions the bowl is revolving per minute. After speed has been reached, the milk should be turned on full speed, until both cream and skim-milk flow from the respective spouts; then it should be closed off until the cream is of the desired thickness. The cream should be the guide in operating the separator.

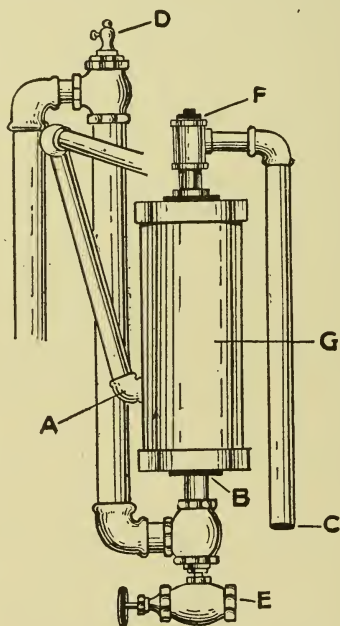
The cream left in the bowl when all the whole milk has been put through should be forced out with warm water. From one to two pails will be needed for this purpose. Shut off the feed-tap for a few seconds when about half the quantity has gone through; then turn it on again, allowing the remainder to complete the operation. Pure warm water is preferable to skim-milk, as it is nearer the specific gravity of the cream, and consequently displaces it more readily.

Allow the bowl to stop of its own accord after the power has been removed; never apply any brake or friction to the intermediate. Remove the solid matter found at the extreme outside of the bowl and burn it at once. Clean out all milk tubes with the spiral provided; wash with tepid water thoroughly; scald with steam or boiling water; then place on a draining rack where the bowl and its parts may dry. Never close the bowl when wet inside, as it will cause it to rust. Leave it open when not in use so it will be thoroughly dry.

In ordering the parts for the separator always specify exactly what is wanted by the use of the proper name and number of the same. This can be found by consulting the book of instructions furnished with all machines. A duplicate set of the delicate or wearing parts of any machine should be kept on hand for emergencies.

Milk fresh and warm from the cow is in the best possible condition for a perfect separation. The difference in specific gravity between the fat and other portions of the milk is then greatest, and is also more fluid, as there is no development of lactic acid, nor chemical changes due to its exposure to the air. At the creamery, it is not met with in this favorable condition; consequently it is necessary to produce artificially as many of the favorable conditions as possible to get the best results. When milk is received at a temperature below 85° it should be heated to from 90 to 100°.

A tempering vat should be elevated at a suitable height to allow the milk to flow into the separator; and it should contain enough milk to



SKIM-MILK PASTEURIZER USING
EXHAUST STEAM.

A. Milk inlet 1½" pipe. B. Exhaust steam inlet 2" pipe. C. Overflow 2". D. Small valve on exhaust steam pipe to prevent suction of skim-milk back into steam pipe. E. Valve to drain heater. F. Plug which may be removed in order to see if heater is filling with material from skim-milk. G. Heater 6" diameter, 18" long with caps screwed on each end.

employ the separator for at least four minutes. If large bodies of milk are heated to the desired temperature in a vat before separating, acid develops too rapidly and clogging of the separator bowl is likely to follow. Should any accident happen whereby the separator is stopped, the milk would likely develop acid enough to thicken, when it could not be separated.

While it is doubtless true that better butter can be made by pasteurizing the whole milk before separating, still the improvement is not enough

to compensate for the extra labor required in cleaning the separator and utensils. There is also the fact that the separator bowl will need to be retinned often if separating pasteurized milk.

The plan followed at the Dairy department at the present time is to heat the milk to about 95° before separating. The cream is delivered from the separator into the pasteurizer and heated to 180 to 185° . The skim-milk is elevated by a rotary pump and just before entering the tank it passes through a heater in which exhaust steam from the engine is used for pasteurizing the skim-milk. The cut will show how this heater may be made. A union should be put in the steam pipe somewhere near the heater, as the heater will need to be taken apart at intervals to be cleaned. This can best be done by burning in the furnace. The amount of milk, and the temperature to which it is heated will determine how often it should be cleaned. Usually it will run from six to eight weeks without requiring to be cleaned.

A great saving in fuel can be made by utilizing the exhaust steam from the engine. At the Dairy department the pipes are so arranged that the exhaust steam can be used for heating the whole milk before separating, heating water, pasteurizing the skim-milk, and heating the building.

Two other labor and trouble saving devices are in use at the dairy which are worthy of special mention. One is a skim-milk weigher which after four years' use we would find it very difficult to get along without. The other is an Ideal hoist for elevating milk at the intake. Having the driveway graded so that no lifting of the can is required is the best plan, but where this cannot be accomplished, the Ideal hoist would seem to be a very satisfactory means of elevating the milk.

PULLEYS AND BELTING. The following rules for finding the size of pulleys and the required length of belting will be found useful in fitting up a creamery or in placing additional machinery.

To find the diameter of a driven pulley, multiply the diameter of the driver by its number of revolutions, and divide the product by the number of revolutions the driven pulley should go. The result will be the diameter of the driven pulley.

Example. Diameter of pulley on the engine, 40 inches; speed of engine, 160 revolutions; speed in main shaft, 200 revolutions: $40 \times 160 \div 200 = 32$, which is the diameter in inches required for the driven pulley.

To find the required size of a driving pulley, multiply the diameter of the driven pulley by the number of revolutions it should make, and divide the product by the revolutions of the driver.

Example. Diameter of the pulley in intermediate is 4 inches, which is required to run 900 revolutions per minute; revolutions of shaft, 200: $4 \times 900 \div 200 = 18$, which is the diameter in inches of the pulley required to drive the intermediate at proper speed.

To find the length of belt for any two pulleys, add the diameter of the two pulleys together, divide this sum by 2, and multiply the quotient by $3\frac{1}{4}$. Add the product to twice the distance between the centres of shafting, and the result will be the required length of belt.

Example. Two pulleys are 8 and 24 inches in diameter, and 8 feet is the distance between the centres of the shafting. $8+24=32$, $32\div 2=16$, $16\times 3\frac{1}{4}=52$ inches= 4 feet 4 inches, and 4 feet 4 inches $+16$ (twice the distance between the centres of the shafting)= 20 feet 4 inches, which is the length of belt required.

CREAMERY BUTTERMaking.

By C. W. McDougall.

The practice of the art of buttermaking must always be one of evolution. Advancement is an assured result when we earnestly endeavor to make our practice conform to methods that have been proven to be superior to our own. These superior methods may be the result of scientific investigation or of the intelligent observation of practical men. To teach any method as an infallible one would be assuming a false position. The claims made for the perfection of the method would in reality be a reflection upon the intelligence of the scientists and buttermakers of the future. On the practical side of the question, however, we know that we do not adapt with sufficient readiness methods which would produce a marked improvement.

We should all like to have our supply of milk and cream in what we now think is first-class condition, and have the butter made in a modern creamery by the most improved method. Granting that we accomplish all this, we should find that there still remains room for much investigation and improved practice. When we recognize this fact where are we to look for justification in our too common method of blundering along in the dark at the mercy of so many foes? It would be quite difficult to find a more unscientific practice than that of some of our buttermakers at the present time.

On the farm, the intelligent production of milk and the proper care of this milk, or the cream obtained from it, are very essential factors in the manufacture of good butter. This is especially true in the case of creameries operated on the cream-gathering system, for here each patron becomes to a large extent a buttermaker, as he handles the cream at one of the most important stages of buttermaking. It is to be taken for granted that all creamery patrons know the value of having good cows supplied with an abundance of good food, pure air, water, etc. On these we must depend for the natural flavor or individuality of the milk or cream, and it may be said on behalf of our creamery patrons that very little complaint can be made on account of poor flavored milk at the time it is taken from the cow. But when we consider the length of time the milk or cream is cared for by the patrons, and the quality of this care, we find evidences of inexcusable neglect. To take wholesome milk from a kind

and generous cow amid foul surroundings and deliberately put it into unclean pails, through unclean strainers, run it through a filthy separator, or leave the milk or cream at a high temperature, is nothing short of a crime against the State. As soon as milk is produced it begins to decay, and the rate at which this decomposition takes place will almost entirely depend upon the amount of dirt which has been incorporated with it, and upon the temperature at which it is held. On these two points there is still much room for improvement.

It is practically impossible to avoid getting at least a small amount of dirt into the milk, and with this dirt are introduced countless numbers of bacteria. At this stage we must act with promptness to prevent as far as possible the harmful effects of these bacteria. Where the milk is to be sent to a whole milk creamery, cool at once to a temperature of 60° or below, cooling Saturday night's and Sunday morning's milk much lower. The holding of cream for two, three, or more days is a very bad feature of our cream-gathering system. This means the hopeless destruction of fine butter quality in the cream unless ample preparation is made for, and thorough care taken of, each lot of cream. Treatment that will assist in retaining this fine butter quality is to be found in skimming a rich cream, pasteurization, or holding the cream at a low temperature. The cream separator furnishes the best means of getting a rich cream, but if we cannot get a separator that will do close skimming while delivering a rich cream, and that can be purchased at a reasonable price, we are better without one. The serum or skim-milk portion of the milk furnishes the bacteria with food for growth and reproduction, the fat in itself not being a bacterial food. For this reason the more milk drawn off as skim-milk the fewer bacteria we have in the cream and the less serum for them to feed upon.

The cream from the separator should test not less than 30 per cent. fat. A rich cream gives the buttermaker better control of his part of the process as well as being beneficial to the patron. The cream should be cooled immediately to at least 45°. This temperature applies to all creams to be sent to a creamery whether they be from the centrifugal or gravity methods. Pasteurization is a very efficient method of preservation. The heating and extra cooling, however, mean more work and expense than would be considered practicable under average conditions. Nature, in her kindness, has in this country supplied us with an abundance of ice for keeping our cream cold, but the average creamery patron simply ignores this fact, supplies a cream out of which a first-class butter cannot be made, and then grumbles at everyone but himself when he is reaping the reward of his own transgression.

A great many creamery patrons will argue that cream is not sour until it has coagulated or thickened, whereas about half of the possible acidity is produced before this condition is noticed. Cream must be in good condition when taken up by the cream hauler so that good butter can be made from it after being on the cream wagon and in the creamery for the greater part of a day. The fact of a cream hauler accepting a patron's

cream is certainly not the end of that patron's responsibility. The transportation of cream in cream tanks and the ignorance and indifference of the cream gatherer have permitted abuse in putting poor lots of cream into the tanks. It is true that the tanks and jacketed cans in use are important factors in maintaining a low temperature of the cream, but the abuses connected with their use would seem to make the adoption of the individual can system very desirable.

The adoption of the individual can system permits of the rejection of poor cream or the proper recognition of the patrons supplying good cream by payment according to quality. In addition to this the possible abuses existing through the work of the poor cream hauler are largely avoided, and the chief qualification of all cream haulers under this system consists in their ability to deliver the cream at the creamery in the shortest possible time.

To have a good flavored, rich and sweet cream furnished by the patrons, and to have this cream taken under first-class conditions to the creamery, at least three times a week, would materially aid in the improvement of the quality of the butter.

That part of buttermaking which is more directly the work of the creamery operator and manager is a very large one and is weak on many sides. We are not lacking so much in technical knowledge or instruction as we are in the intelligent application of principles we already know. If we are to keep a choice butter for home or export market in view, we must admit that our average creamery is lacking in such essential equipment as a pasteurizer and cooler, and has only an apology for a butter storage. We have too many poor creameries with an equipment that is not at all up to date. Of course, it can be argued with good reasoning, that the construction, equipment and consistent operation of an ideal creamery may be a poor business venture, but this is not sufficient excuse for our common method of endeavoring to get sufficient cream to make a large quantity of medium grade butter at a minimum cost or maximum commission in manufacture. A creamery must have sufficient cream to make its operation practicable, but associated with this should be the rejection of poor cream and the handling of the remainder in the best possible manner. We owe this to our good patrons before we are reasonably entitled to their patronage. If we are going to improve the quality of our export butter we must prove ourselves greater masters of the essentials embodied in this improvement.

Sufficient work has been done in the churning of sweet pasteurized cream to demonstrate that the butter made by this method has an excellent keeping quality.

Good methods of work vary, but the following outline is good practice. The cream is pasteurized at 185° and cooled to a temperature of 40 to 45° if to be churned as soon as separated. This low temperature practically necessitates a cream cooler operated in connection with a mechanical refrigerating plant or by pumping through the cooler the brine from a tank containing cold brine or water and ice. As high as 30 per cent.

of the good culture may be used to advantage. When the milk is inferior skim a very rich cream and use a high per cent. of culture. When the cream is to be held until the following day, add little or no culture if the quality of the milk is good; if the quality is not good, skim a rich cream and dilute with good whole milk and culture, or skim-milk and culture especially selected. Churning the cream the following morning will give a more exhaustive churning than if churned immediately after separating and cooling, and so low a temperature for solidifying the fat will not be necessary. As in ripened cream, the same principles guide the churning operations, though special precautions should be taken to avoid churning too quickly. A cooling of the culture before adding it to the cold cream will prolong the churning period by making a lower average temperature of the contents of the churn.

It should be our aim to pasteurize all cream to be used in butter-making. This will be beneficial in all cases when the highest quality of the butter is being considered, and will permit of a much lower cream acidity to produce an equally exhaustive churning. Keep the temperature of the cream at the pasteurizer up to 185°.

The period of cream ripening is one of decomposition and should be under positive control. The production of high acid should be avoided in even pasteurized cream unless a higher flavor is needed for local or special market. Four-tenths of one per cent. acid is sufficient. In the handling of any cream, the use of an efficient cream cooler is very desirable. The absence of a modern cream cooler in our creameries is, season after season, causing excessive losses of fat in the buttermilk and decreased quality of the butter.

In unpasteurized cream as low an acidity as will produce an exhaustive churning should be used. This could be increased where a higher flavor is demanded or where an acid flavor will be less objectionable than a poor flavor already present. The temperature should be uniform throughout the cream, as the portions of the cream remaining at the higher temperature have their churnability increased both by the increased lactic acid development and decreased solidifying effect of the higher temperature, while the portions remaining at the lower temperature have churnability decreased both by the decreased lactic acid development and greater solidifying effect of the lower temperature upon the fat globules. Uneven ripening temperatures means extra losses in the buttermilk and uneven granules during churning. The resulting condition is really uneven amalgamation of the fat globules during the operation of churning. If an exhaustive churning of unpasteurized cream can be had below .55 per cent. acid do not exceed this amount.

Avoid extremes in the length of time for churning. From 30 to 45 minutes is good practice. Endeavor to get a balance of conditions from the amount in the churn, speed of the churn, quality of cream, etc., so as to have ample and uniform concussion of the contents. Do not churn very rich or thick cream in churns having internal projections or pockets that furnish a place for lodgment of the cream.

Avoid high and very low churning temperatures; a fairly low one is preferable. Endeavor to get body in the fat globules by using a low ripening temperature. A vigorous growing lactic acid culture will produce sufficient acid at a temperature of 50°. Draw off the buttermilk as soon as it will readily separate. Having the granules small when the buttermilk is removed, thoroughly rinsing them, then adding sufficient water and increasing the size of granules to that of large corn is good practice. Endeavor to get angular granules and avoid very low or high temperatures of the wash water. Wash water very low in temperature makes a condition favorable for the production of mottles, while the high temperature creates a condition demanding great skill. Having naturally firm granules, and using a fairly high temperature for the last wash water, are productive of greater overrun and is quite practicable under control conditions. Do not practice it if you are not in a position to counteract the risks entailed. In all cases, only wash water which is pure should be used. All doubtful water should be subjected to a chemical and bacteriological analysis before using.

The best salt obtainable should be purchased and care should be taken to store it in a dry place which is free from tainting odors. If preservative is used it should be evenly mixed with the salt. An ordinary flour sifter suits admirably for this purpose. Sift or spread the salt or salt and preservative onto the butter as evenly as possible, doing it in three or four applications, turning the butter each time. The best distribution in working, and the most economical use of salt is obtained by having a moist granule with a small amount of free wash water and relatively a small working area. After the butter has massed, open all faucets to permit of the ready escape of free brine.

The proper amount of working to be given to the butter will be best ascertained by observing the results of different amounts under the one system for successive days. We must secure an even distribution of the salt and expel an excess of free moisture. A slightly overworked condition of the butter is preferable to a mottled condition even if the grains be better in the latter.

All butter packages should be neat, strong and made from non-tainting material. Perfect cleanliness should be observed in lining and packing all boxes or tubs and in wrapping prints. The market to be supplied will largely determine the style of package and manner of packing. Only the very best parchment paper should be used, and it should be cut while dry so as to finish neatly when the package is filled. Soak the parchment for twenty-four hours in a saturated solution of salt; if sufficient formalin is added to this brine to destroy mold, the incorporation of the mold spores will be prevented. Add small amounts of butter at a time to the package, in order that the packing may be more thoroughly done. Pack in considerably more than the requisite amount, and then, by means of a straight edge, cut out to a weight which will allow for ample shrinkage. The impressions of a fluted roller on this surface will relieve it of its plain and sometimes greasy appearance. Fold the parchment over the butter as

neatly as possible. The preservation of the butter is best obtained by putting it into low temperature storage as quickly as possible.

Eternal vigilance is the price of keeping a creamery and its equipment in good condition. Dirt and conditions favoring its collection demand prompt and thorough attention. These are factors in the purchase of all creamery machinery and utensils. Machinery should be purchased subject to a test under practical conditions, and efficiency rather than first cost should be the guide in purchasing.

HAND SEPARATORS.

BY GEO. R. TAYLOR.

The hand separator problem is one of the most important questions before the dairymen, and especially the creamerymen, of our country at the present time. When the whole milk system of buttermaking was in vogue, the buttermaker had control of nearly all the conditions which tend toward the production of a high grade product. The milk then had to be in a sweet condition when it was received at the creamery or it could not be separated. This being the case, the buttermaker had pure, sweet cream to work with, and he was held responsible, and justly so, if a first-class product was not manufactured. With the general adoption of the cream-collecting system of buttermaking, however, a much different state of affairs exists. The patron of the creamery separates the cream from the milk, either with a hand separator or by other means. The cream is delivered at the creamery once, twice, or three times a week, and owing to various causes, is too often received in a very poor condition. The buttermaker may then try to make a first-class quality of butter, but will often meet with only a small measure of success. It is important, therefore, that the patron should understand how to operate a separator to get the best results, and also understand the principles to be observed in caring for the cream.

Some of the most potent causes of poor cream are:

1. Improper care of the cream after separation.
2. Having the separator in an impure atmosphere.
3. Carelessness in washing the separator, or neglecting to wash it each time after being used.
4. Skimming a cream too low in butter fat.

Carelessness or neglect in washing the separator, separating the milk in an impure atmosphere, or carelessness in caring for the cream are the common causes of bad flavors in the cream, and in each case the trouble may be easily overcome by a little extra care on the part of the person operating the separator.

A cream poor in milk fat, or one containing a large amount of skim-milk, is objectionable for many reasons, both to the farmer and to the

creamery man, and the separator agent who advocates the practice of skimming a thin cream and washing the separator once a day or only when convenient is not working for the best interests of the dairy industry. Agents who advocate such a practice have only one object in view, and the machines which they are offering for sale are likely to be either separators that are hard to wash, or those that are not well adapted for skimming a cream containing a high percentage of fat, and intending purchasers should consider very carefully the merits claimed by these agents for their particular machine.

Thin cream contains a large amount of skim-milk which is valuable to the farmer for feeding purposes. It requires more water and ice for cooling, and in it the conditions are more favorable for the rapid development of lactic acid and bad flavors. The cost of delivering the cream at the creamery is greater on account of the larger quantity. The butter-maker has to supply extra vat room, and it is more difficult to get good results in churning.

When milk is set for cream to rise either in shallow pans or deep cans, the force of gravity compels the heavier portion to go to the bottom, and the cream being lighter rises to the top, and is separated more or less perfectly from the skim-milk. But when milk is delivered into a rapidly revolving separator bowl, the centrifugal force acts with much greater intensity. Separation takes place almost instantly and is much more perfect.

The hand separator has many advantages over the shallow pan and deep setting methods of creaming milk, and its disadvantages are comparatively few.

Some of the advantages are :

1. The loss of fat in the skim-milk is reduced to a minimum.
2. It saves the cost of utensils and the space required for their accommodation.
3. It gives a better and more uniform quality of cream and butter.
4. The richness of the cream can be easily regulated.
5. It saves labor in washing utensils and in the handling of ice for cooling purposes.
6. The skim-milk is in the best possible condition for feeding young stock.

The chief objections to the hand separator are its first cost and the labor of turning and washing the machine; but when we consider that the increased product made from the saving in loss of fat in skim-milk alone, over the best of other methods of creaming, to say nothing of its other advantages, amounts to from five to ten dollars per year for each cow, it will be seen that the separator will soon pay for itself. The labor of washing the machine is also a small consideration when compared with the labor of washing the utensils required for either the shallow pan or deep-setting methods.

The cost of a hand separator is from \$50 to \$150, according to the size and capacity, and they will skim from 150 to 700 pounds of milk per

hour. A separator having a capacity of 450 pounds per hour is of sufficient size where from eight to ten cows are kept.

In choosing a separator it is advisable to select one with a capacity somewhat larger than is required for immediate use. The feed tap may then be slightly closed, and the skimming done with the separator running a little below its capacity. This makes a favorable condition for the separator to do close skimming, and also for the production of a rich cream which is so desirable at the present time. All, except the smallest sized machines, are so constructed that they may be connected with power and much labor may be saved in this way. The most common power in use is the tread power. It may be run by any farm animal with good satisfaction. A small gasoline engine is also a very efficient power where the separating room can be placed at a suitable distance from the barn, to avoid any possible danger of fire. There is also danger of tainting the cream from the odor of gasoline.

There are many different makes of separators on the market at the present time, but which is the best it is impossible to say, as no one separator comprises within itself all the points of merit that the ideal might possess. The best separators might be described as those best suited to the special conditions under which they are to be used. It may be that the less capable of two separators is the better, for the reason that it may have advantages and conveniences which at first might seem of little importance, yet be of great value in the peculiar circumstances under which it is to be used. For example, the closest skimming separator may be more difficult to operate, more inconvenient to clean, or possess other disadvantages in its mechanism less desirable than a machine which skims less closely, and these disadvantages may more than counterbalance its closer skimming power. A hand separator may be considered to be doing good work, when, running at its full capacity, it will produce a cream testing over 30 per cent. fat, and leave not more than one-tenth of one per cent. (.1) of fat in the skim-milk, or a reading not extending over one space in the graduated neck of a skim-milk test bottle.

The points of merit which a separator should possess are :

1. Simplicity and strength of construction.
2. Cheapness and durability.
3. Maximum capacity with minimum power required to turn.
4. Closeness of separation.
5. Desirable richness of cream.
6. Ease of cleaning.

With each separator is sent a book containing full directions for setting up, and operating the machine. This should be carefully read before removing the machine from the box. A suitable place for setting it up should then be chosen, care being taken to select one that is well ventilated, and where a pure atmosphere can at all times be assured. It is most convenient to have the separator in the barn, as it saves the labor of carrying the milk to the house and the skim-milk back to the barn, but the practice of allowing it to occupy a stall in the stable is very objectionable,

on account of the injurious effect on the flavor of the cream, and injury to the machine due to dust and dirt getting into the bearings.

The frame should be fastened securely to a solid foundation, and the part of the frame containing the bowl should be perfectly level on top in all directions. A small quantity of quarter-inch rubber packing, placed under the outside edge of the base or under the legs before fastening, improves the running of any separator.

Before the separator is started all parts should be thoroughly cleaned and all bearings well oiled. The oil-cups and oil-holes should be in good working condition. Special attention ought to be given to the oil that is used. When convenient, it is advisable to use the oil sold by the agent of the machine, but if not, any good separator oil will do. It should be rather thin, so as to give a clean drop, and be free from any tendency to gumminess when exposed to a very low temperature. It is a good practice to flush the bearings and oil-holes with coal oil once every week or ten days. This removes the thick oil and grit and adds greatly to the easy running of the machine.

Two or three minutes should be taken to get the speed up to the required rate, which is usually stated on the crank of the machine. Sufficient water, at a temperature of about 110°, should be added to fill the bowl, to wet and warm the surface and prevent the cream from sticking. The milk should then be turned on full flow, and the feed pan kept well filled until the milk is all in. The speed should be kept well up, and as uniform as possible at all times to insure closeness of skimming and an even richness of cream.

In the use of a separator three things should be carefully watched, viz., the speed of the bowl, the temperature of the milk, and the feed of the milk to the bowl. With the same machine, and all other conditions the same, the greater loss of fat must be expected when the separator is not run up to the required speed, or when the milk is below a certain temperature, or when more than a certain amount of milk is run through in a given time.

Milk separates best when fresh or new, and at a temperature of 90 to 100° F. Tests made with different hand separators with milk at temperatures below 80° showed, in every case, a much greater loss of fat in the skim-milk than when similar milk was separated at a temperature over 95° F. Therefore, if for any reason the milk has been allowed to cool below 85° it should be heated again before separating if close skimming is desired. When the milk is all run through, the cream should be flushed from the bowl with a little warm water or skim-milk. The power may then be removed and the speed allowed to run down of its own accord. The bowl should not be stopped by applying a brake of any kind, unless provided by the manufacturer, as it injures the bearing and shortens the usefulness of the machine. All parts of the separator should then be thoroughly washed, first in tepid water, and afterwards scalded, then placed in a pure dry atmosphere until required for further use.

The richness of the cream may be regulated by the adjustment on the machine which will be either a cream, or a skim-milk screw. If the adjustment is by means of a cream screw, the cream may be made richer by turning the cream outlet towards the centre of the bowl, and thinner by turning it away from the centre or towards the outside.

In the case of adjustment by means of a skim-milk screw, the directions would be the reverse.

Other conditions which influence the richness of the cream are the speed of the bowl, and flow of milk into the bowl, and, to a certain extent, the temperature of the milk. High speed and a low feed give a rich cream, while a low speed with a regular or increased amount of feed will give a thin cream, and probably this accounts for the great variation in the cream tests from the same machine.

A low speed with a full feed of milk makes a very unfavorable condition for a separator to do good work, and should not be used as a means of lowering the test, as it is usually associated with a high loss of fat in the skim-milk.

The care of the cream is by no means the least important part of the work. As soon as the separating is completed the cream should be cooled immediately to as low a temperature as possible in the summer and to a temperature below 60° in the winter. When different lots of cream are to be mixed, the fresh cream should always be thoroughly cooled before it is put in with the old cream. Adding fresh warm cream to cream that has been separated and held for some time causes the development of lactic acid, which, if not properly controlled, will cause bad flavors in the cream and butter.

FARM BUTTERMAKING.

BY MISS LAURA ROSE.

Every year less butter is being manufactured on the farm; and this is as it should be, for while I teach home-dairying, still I am a great advocate of co-operative dairying.

Good butter can be and is made on the farm, but from lack of skill, care, or improper surroundings or utensils, dairy butter very often lacks the fine flavor and body in a No. 1 quality.

As civilization advances, conditions multiply. In a new country the milk and butter is apt to be better than that produced in a thickly settled district. This is owing to bacteria of an objectionable nature being less prevalent and as a result milk and its products are not so liable to contamination.

Cleanliness from the very start to the finish is the great essential in the art of making good butter, and too much stress cannot be laid upon its importance.

THE COW.

Farmers are far too well satisfied with the cows they keep. Were they their hired help they would not give them shelter another night. They would let them go for the simple reason that they did not earn their bread, let alone showing the smallest profit. We must, if we wish to make dairying pay, increase and improve the milk. A cow that is well fed and cared for should produce 6,000 pounds of milk containing 3.6 per cent. butter fat, or should make 250 pounds of butter per year. I would urge farmers to weigh the milk from each cow at least one day every month and test it for butter fat. This is the only accurate way of making comparisons and finding out what the herd is doing individually. The cow stable should be well lighted, well ventilated, and kept clean. Give the cows plenty of wholesome food. It is the poorest economy to stint the cows either in the matter of food or water. Also see that salt is always accessible to the cattle.

MILKING.

There is no nicer place to milk cows than in a well-kept stable. Milk quietly, quickly, cleanly, and thoroughly. Cows do not like unnecessary noise or delay. Commence milking at the same hour night and morning, and milk the cows in the same order. Wipe the cow's flank and udder to prevent loose dirt and hairs falling into the milk. Do not wet the hands with milk. A practice to be recommended is rubbing a little vaseline on the hands. This keeps the teats in nice condition and overcomes the objection some have of milking with dry hands. Nothing tends more readily to drying up the milk flow than leaving a little milk in the udder.

STRAINING THE MILK.

Remove the milk as soon as possible from the stable, and immediately strain through several thicknesses of cheese cloth. Place the cheese cloth over the bottom of the strainer, and secure it with an easily fitting tin hoop. The cloth must be removed and well washed after each time of using.

CREAMING THE MILK.

SHALLOW PANS. This method is the oldest, and is still used when but a few cows are kept or when ice cannot be secured or the supply has become exhausted. Tests of the skim-milk show that when the milk has been properly set and skimmed, the loss of butter-fat is no greater from the shallow pans than from creamers. The milk should be set in clean, bright tins, and should not exceed three inches in depth. It is most necessary that the milk room be clean and free from all odors, as milk so readily absorbs any taint that may be in the atmosphere. The temperature should range between 50 and 60°. Avoid having the milk close to the wall or in

a strong draught, so as not to have a leathery coat form over the cream, due to rapid evaporation. Skim before the milk thickens. Loosen, with a thin bladed knife, the cream from the sides of the pan. Lift the pan to the edge of the cream can, tilt it to allow a little of the skim-milk to wet the edge of the pan, then with the aid of the knife, quickly glide the sheet of cream into the cream can.

DILUTION SYSTEM. Many devices have been put on the market for creaming milk by adding a certain percentage of cold water. We have tried several, and do not recommend any. There is danger of contaminating the cream by using impure water. It robs the cream of its flavor, and besides the loss of butter fat is usually heavier than when the deep cans are used. The skim-milk is too much diluted for feeding purposes.

CREAMER. If the cream is raised by the deep setting system, the cans should be placed immediately in water the depth of the milk and the milk brought as soon as possible to 45° or below, and held at that temperature. *Use plenty of ice.* It is economy to have ice always in the water, and just as necessary to use it in the winter as in summer. A water-tight box or barrel will do as effective work as an expensive cabinet creamer. We prefer a slant-bottom can, with a tap to draw off the milk. Having the slant carries away any sediment and permits all the skim-milk to be drawn off.

Cans without a tap should be skimmed with a funnel-shaped dipper, having a long straight handle and no wire around the rim. With a knife loosen the cream from the sides of the can, then wet the dipper in water or milk, and lower, point first, into the can, allowing the cream to flow evenly into the dipper. Repeat until all the cream is removed. Avoid getting too much skim-milk with the cream.

Milk should always set twenty-four hours before the skim-milk is drawn off, and thirty-six hours in winter is even better. Milk allowed to stand only twelve hours before skimming will give a cream testing from 16 to 18 per cent. butter fat, while the skim-milk will test as high as from .6 to 1 per cent. Cream from milk allowed to stand twenty-four hours will test from 18 to 22 per cent. butter fat, and the skim-milk from .25 to .35 per cent., or in other words we have in the latter case a richer cream and less loss in the skim-milk—two desirable conditions in the creaming of milk.

CREAM SEPARATORS. A separate article in this bulletin is devoted to the hand separators; otherwise, much might be said in favor of this method of creaming milk. It certainly is the ideal way of obtaining the cream. A separator, even with only a small herd, pays, for it should mean less labor, better cream, and more of it.

CARE AND RIPENING OF CREAM.

During the collection of cream for a churning, the cream can should stand in the coolest place in the cellar in summer, while in the winter it may be kept in a room where the temperature ranges between 50 and 60°.

The surrounding atmosphere should be clean and sweet. The can must always be covered. Have a tin stirrer which reaches to the bottom of the can and stir thoroughly, from the bottom to the top every time fresh cream is added.

Each time the can is emptied it should be well washed, scalded and put in the sunshine for several hours. In order to be able to do this, it is a good plan to have two cream cans.

When beginning to collect cream for a churning, add to your first skimming a culture or starter which you know has a clean, pleasant, sharp acid flavor and smell. This culture may consist of a pint or two of sour cream from your previous churning or the same amount of good-flavored skim-milk. The reason for adding the culture is that the bacteria which you know produces a fine flavored butter may take possession of the new cream before other germs which might prove objectionable gain control of it.

Another method is to hold the cream sweet until twenty-four hours before churning, then heat it to 65° and add one pint of culture to every gallon of cream. In the evening cool to churning temperature or below, and hold at that temperature over night.

Separator cream should have the foam well stirred in, and by placing in cold water, should be quickly cooled to 60° in winter and from 50 to 55° in summer. Stir the cream occasionally while cooling. It is most essential that this thorough and quick cooling be done before adding the cream to the cream can, otherwise separator cream cannot make choice butter.

Examine the cream, and when it has a smooth, glossy appearance, pours like molasses and has a pleasant acid taste and smell, it is in proper condition to churn. Churning should be done not less than twice a week in summer and three times in two weeks in winter.

To insure a good body in the butter have the cream lowered to churning temperature or below several hours previous to churning. It does no injury to raise the temperature to that desired, but when the temperature of the cream is lowered just before churning, the fat globules have not had time to harden and the result will be a soft, weak-textured butter.

To prevent loss of butter fat in the buttermilk, sweet cream should not be added during the last twelve hours before churning.

Perfectly sweet cream will churn in the same time as ripened cream and makes a mild creamy-flavored butter which is gaining in favor in the best markets. If the temperature of sweet cream is kept low there is no excessive loss of butter in the buttermilk.

Complaints are sometimes made about a bitter flavor in cream. When held sweet for some time at a very low temperature this bitterness frequently develops. To overcome this difficulty, either pasteurize or get the cream started to sour.

For farm buttermaking we do not consider pasteurizing the cream necessary, but if bad flavors are found in the sweet cream it will to a great extent destroy them. To pasteurize, place the can holding the cream in a

dish of hot water on the stove, and bring the cream to 160°, and keep at that temperature for twenty minutes; then quickly cool to about 60°. It is always necessary to add a culture to pasteurized cream if you wish to ripen it.

THE CARE OF THE CHURN.

Before using, the churn should be scalded with boiling water and afterward rinsed with cold water. It is better and quicker to pour the water out than let it run through the bung-hole. Floating dust will not then cling to the sides of the churn. After using, the churn should be rinsed down with hot water, thoroughly scalded with boiling water, then given a scouring with salt, followed by another rinsing with hot water. Wipe the outside, but do not touch the inside with a cloth. Never allow buttermilk or wash water to remain in the churn when not in use. Leave the plug out and the lid ajar, and keep in a cool place to prevent warping.

The worker, ladles, and butter-print may be prepared while the butter is draining. With a fibre brush, a dipper of water, and a little salt, give them a good scouring and cool well with cold water. After using remove any butter with hot water, again scour with salt, rinse with boiling water and allow them to dry.

CHURNING.

Always strain the cream into the churn through a dipper with a perforated tin bottom. In winter add just sufficient butter color of a reliable brand to give a nice yellow tint. Do not depend on pouring it in, but count the drops for a small churning, allowing 3 or 4 drops to the pound of butter.

No definite temperature for churning can be given, but the necessity for the constant use of a thermometer must be emphasized.

Many conditions influence the temperature of the cream for churning such as the richness of the cream; the quantity in the churn; the feed and breed of the cow; the length of time the cows have been milking; the temperature of the room; and the speed of the churn. Aim to make conditions favorable to a low churning temperature as it insures a better butter and a more exhaustive churning.

Start with the churn about one-third full, which means not more than five gallons in a No. 3 churn, and regulate the churning temperature so as to have butter within from 20 to 30 minutes. That proper temperature can only be ascertained by past experience with similar cream.

I would suggest a range of temperatures for summer from 54 to 58° and in winter from 58 to 64°.

Cream that contains too much skim-milk and is too cold will foam. Never add hot water to the cream. It must be taken from the churn and heated by placing the can in a pan of hot water and stirring until the desired temperature is reached.

Poor cream often breaks, but will not gather. Try churning slowly. If this does not overcome the difficulty the only remedy is to draw off part of the buttermilk to lessen the liquid.

Very rich cream is likely to paste or thicken in the churn, so that concussion ceases. Add enough water at the same temperature as the cream to dilute it so that it will drop.

When the churning is about completed, add a couple of quarts of water several degrees lower in temperature than the cream was. In the summer it may be quite cold. This floats the butter and allows the buttermilk to run off more freely. When the butter is the size of wheat grains it is sufficiently gathered. Look frequently at the inside of the churn lid, and when but few small specks are seen on it, the churning is usually finished. Watch the buttermilk as it runs through the strainer dipper, and if any butter comes with the first streams, a little more churning is necessary.

WASHING THE BUTTER.

When the buttermilk is drawn, rinse the butter with a little water and strain through cheesecloth into the churn as much water as there was cream. Temper the water in winter, having it from 48 to 56° according to the conditions of the butter and the temperature of the room. In hot weather the wash water may be as cold as possible. Revolve the churn rapidly about a dozen times, and wash but once. We recommend washing butter twice if it has come very soft or has an objectionable flavor, or is going to be packed for winter use.

SALTING THE BUTTER.

Salt according to the demand of the market. If the butter is for immediate use and is salted on the worker $\frac{3}{4}$ ounce per pound of butter is usually sufficient. If salting in the churn use an ounce, as not so much is incorporated in the butter. We strongly recommend salting in the churn, as by so doing butter free from streaks can be had with the least possible amount of working, but the churn must be without dashers, and the butter in firm granular form. The only difficulty in this method is gauging the amount of salt. Estimate the weight of butter from the last churning, then weigh the salt. Have the butter evenly spread over the bottom of the churn, sift on part of the salt, tilt the churn forward to cause the butter to lap over, sift on more salt, then tilt the churn backward and put on the remainder of the salt. Put on the lid and revolve the churn very slowly until the butter forms in several lumps. It may be taken out and immediately worked, but if possible it is much better to allow it to stand either in the churn or in a firkin, if the churn is in too warm a place, for two or three hours, and then give one working.

If salting on the worker, take the butter from the churn, weigh it, and allow $\frac{3}{4}$ ounce of salt per pound of butter. Spread the butter over the worker, sift the salt on evenly, fold the salt under and begin working.

WORKING THE BUTTER.

For the farm dairy there is nothing nicer than the V-shaped lever butter-worker. It is not expensive and is a great saver of time and strength, besides preserving the grain of the butter.

Work by means of pressure only; avoid a sliding motion, as it makes a greasy, salvy butter. Work sufficiently to expel the moisture and thoroughly distribute the salt. Any portion of the butter not reached by the salt will be light in color.

If the butter is very soft or very hard, work but slightly, allow it to stand, and when at the proper firmness give it a second working.

PRINTING THE BUTTER.

The brick-shaped pound print is the most popular form in which to market butter. Finish the butter smoothly and press the print down into the butter until the mould is well filled. Cut with a ladle the surplus butter from the bottom. Wrap the print neatly in good parchment paper, which has been previously wet in clear, cold water. It is a good plan to have the paper stamped with the name of the farm or butter-maker. It is often the means of securing a choice trade. Be sure the print weighs a full pound or slightly over. The butter when wrapped in the wet paper should weigh full 16½ ounces.

Keep the butter in a cool clean place and get it to the consumer as soon as possible.

PACKED BUTTER.

When the butter is to be kept for winter use we advocate pasteurizing the cream and seeing that in every respect it is of No. 1 quality. Wash twice and salt heavier. Either allow it to stand in the churn for several hours after salting, or give it two workings. Pack in well glazed, thoroughly-scalded crocks; finish off to within ½ inch of the top. Cover with parchment paper and with a layer of moistened salt. Tie down with paper, and keep in a dark, cool place. If the salt on top dries, add water to it. It is better to keep the butter frozen if possible.

THE MILK PAILS AND PANS.

Clean all tin dairy utensils by first rinsing in warm water, then clean inside and out with a brush and hot water in which a cleansing material such as washing soda is dissolved. Lastly rinse with plenty of boiling water and leave inverted in pure air and sunshine, when available, until wanted for use.

APPLIED PROVERBS.

Praise the day at eventide, and the cow at the end of the year, if she then deserves it.

Children are the riches of the poor; but if you get them interested in the dairy they will help lift the mortgage from the farm.

The shoe knows whether the stocking has holes; the farmer *should know* where the leaks are that rob him of the profits from his dairy, and should set about mending them.

Cleanliness is next to godliness; this applies as much to the *cow stable* as to the *front parlor*.

It is hard for an empty sack to stand straight; but still harder for a lazy man to succeed in the dairy business.

We'll take the good will for the deed. Did you ever hear the cows say that when you neglected to properly feed and water them?

Penny wise and pound foolish is the woman who still uses old-fashioned, out-of-date dairy utensils.

'Tis good in every case you know
To have two strings unto your bow;
Some clucking hens and a brooding sow
Increase the profits from the dairy cow.

Ontario Agricultural College and Experimental Farm,

APPLE CULTURE.

By H. L. Hutt, Professor of Horticulture.

One of our leading nurserymen has observed that the demand for nursery stock of any particular kind of fruit depends largely upon the crop and the prices realized for that fruit the preceding season. If, for instance, apples are a good crop and bring good prices, the next year there will be a great demand for apple trees, but if the crop happens to be a failure or prices are unsatisfactory, many are then ready to tear out their newly planted apple trees and plant whatever fruit seems to be paying best at the time. The folly of such a shortsighted policy need hardly been commented upon. The planting of an apple orchard is an investment which lasts for more than a life time. It is wise, therefore, at the beginning to take a broad outlook and determine upon some definite line of work, and then adhere to it steadily. We can point to numerous apple growers throughout the Province who have made money out of their orchards, but these men did not lose faith, nor neglect their trees, when the crop was a failure or the prices low.

No doubt many growers have been discouraged by the low prices obtained for the fruit in some seasons, yet in most cases it might have been found that this was due largely to the unbusiness-like methods employed in handling and marketing the crop. The outlook for the apple grower never was brighter than at the present. With the reliable information we now have regarding varieties; more rational methods of caring for the trees; improved methods of handling the crop; and local and national co-operation in marketing it, there is no doubt that the apple crop will prove to be one of the paying crops of the future. There is a constant demand for first-class fruit in the best markets of Europe. Then if we realize for a moment the rapidity with which the great North-west is being settled, and consider that in all likelihood the apple will never be successfully grown in that latitude, we may safely count upon the North-west as one of the promising, and ever-increasing markets. In view of these facts, we believe that the Ontario farmer and fruit-grower, who is favorably located for the production of apples, can make no mistake in planting apple trees,—to what extent being determined mainly by the amount of care and attention he is certain of being able to give them.

Apart from the commercial side of apple culture, there is still need for the planting of small orchards on farms throughout the country for home use. It is surprising to find even in good fruit growing districts, such as we have in the greater part of Ontario, that there are yet thous-

NOTE. In the preparation of this bulletin Professor Hutt was assisted by Mr. H. S. Peart, B.B.A., Demonstrator in Horticulture. The section on "Insects Injurious to the Apple" was prepared by Professor W. Lochhead, Professor of Biology.

ands of farms upon which there is not an apple tree growing. The apple is certainly one of the most useful of all fruits, and no one who has a farm can afford to be without a small section devoted to apple trees for home supply.

SELECTION OF VARIETIES.

One of the most important things to be considered in planting an orchard is the selection of varieties. Some of the most serious mistakes in the past have been made in this particular. In many cases worthless varieties have been planted, which is hardly to be wondered at when planters had little more to rely upon regarding varieties than the exaggerated descriptions given by travelling tree agents. But in these days when we have reliable information about all classes of fruits for all sections of the Province published annually and distributed free, as is done in the report of the Ontario Fruit Experiment Stations, there is no excuse for planting anything but the very best varieties suited to each section.

One mistake to be avoided is that of planting too many varieties, particularly in commercial orchards. A half dozen good winter sorts has been found to be plenty. For home use, however, the list might be doubled, or at least lengthened, to suit the preferences of all members of the family. There should, in any case, be varieties enough to cover the season and give a bountiful supply from earliest to the latest. One or two summer varieties, three or four autumn, and half a dozen winter varieties would be about the right proportion of each to plant.

Another precaution which has to be taken in planning a commercial orchard, is that of planting too large a block of any one variety. For convenience in harvesting it is no doubt best to plant trees of the same variety near together, but on the other hand if these blocks of one variety are too large it may be the cause of poor crops, for there are many varieties which are self-sterile, that is, the pollen which they produce will not properly fertilize their own flowers, although it may be quite potent on the blossom of some other variety. This question has not been sufficiently studied to warrant us in saying definitely just which varieties are self-sterile and which are self-fertile, although from experiments which have been made, the following varieties appeared to be more or less self-sterile : Yellow Bellflower, Chenango, Gravenstein, King, Northern Spy, Pinate, Rambo, Red Astrachan, Roxbury, Russett, Golden Russet, Spitzenburg, and Tolman Sweet. None of these should be planted in blocks of more than three or four rows, without some other variety intervening which blooms about the same time. In orchards where such a mistake has been made, it can be rectified most readily by grafting every third or fourth row with some variety which will insure cross-fertilization.

Both tree and fruit must be considered in the selection of varieties. The tree must have sufficient hardiness for the locality, and it is in this

particular that the Fruit Experiment Stations give valuable information to intending planters. Productiveness is also an important characteristic. Unfortunately some of the varieties of most excellent quality, such as the Blenheim and King are lacking in this respect, and, while it may be desirable to plant these for home use, still such a defect is a serious one in a commercial orchard. The age of bearing is another characteristic which varies greatly in different varieties. The Northern Spy, for instance, often requires ten to fifteen years before it comes in bearing, while Ontario, Wealthy, and many of the Russian varieties sometimes bear even in the nursery rows, or at least in a year or two after they are transplanted into the orchard. This is a difference which may well be taken advantage of in the arrangement of varieties in the orchard, for, as a rule, those which are slow in coming into bearing make larger trees and are longer lived, while those which begin early and bear heavily are more or less dwarfed in their growth and the trees are shorter lived. For this reason trees of the precocious varieties are often planted as fillers between rows of the later bearing and larger growing kinds.

The most desirable qualities in the fruit itself depend largely upon whether it is for the market or for home use. For home use, good quality is the first consideration. Usually those having a spicy or characteristic flavor, such as the Spy, King, or McIntosh, are most desirable. Apples with an acid or subacid flavor are most in demand on the market; nevertheless a good sweet apple is often much appreciated for home use. For the market, good appearance is the first consideration. No doubt in time buyers will be more discriminating and demand good quality rather than fine appearance, but at present the most saleable apples are those that keep well, are of fair size and an attractive color. Well colored red apples are those in the greatest demand in the Old Country market, a point which should be remembered in selecting varieties intended for export. Good shipping qualities have also to be considered in the selection of commercial varieties, although no doubt the improvement in methods of packing and shipping may render this of less importance in the future than it has been in the past. The Ben Davis apple has long been recognized as one of the best shipping varieties, on account of its firmness and good keeping qualities. On the other hand, the McIntosh is not a long keeper and is so easily bruised that it cannot be shipped satisfactorily in barrels. But with improved methods of packing and shipping, it may be shipped to any of the European markets and even placed on sale with the Ben Davis, and it is a question how long the Ben Davis, with its inferior quality, will be able in such competition to hold its place in the market. Those who champion the Ben Davis may take exception to the comparison just made because of the relative difference in season of the two varieties. Nevertheless, we believe that it will be safer in the future for growers to look more to the quality of the variety than has been done in the past, for in due time buyers will no doubt become more discriminating and demand apples of the very best quality.

VARIETIES RECOMMENDED TO ONTARIO PLANTERS.

The following list, prepared by the Board of Control of the Ontario Fruit Experiment Stations, contains only a few of the most valuable varieties recommended for planting in Ontario. These have been selected from about 800 that have already been tested in this Province. This list might well be doubled to include a number of valuable kinds for special localities.

In the following lists the varieties are mentioned in their order of ripening. The division into summer, autumn, and winter varieties is an indefinite classification because of the marked difference in the season of maturing in northern and southern sections of the Province, yet, it is valuable to some extent as a guide.

VARIETIES VALUABLE FOR MARKET.

Summer.

RED ASTRACHAN : Adapted to all sections except the extreme north.
 DUCHESS : Adapted to all sections.

Fall.

GRAVENSTEIN : Adapted to all sections except the St. Lawrence River district and the more northerly portions of the Province.
 WEALTHY : Particularly valuable for northern sections.
 ALEXANDER : For northern sections.
 MCINTOSH : Adapted especially to the St. Lawrence River district but can be grown over a much wider area.
 FAMEUSE : Adapted especially to the St. Lawrence River district, but succeeds well over a much wider area.
 BLENHEIM : Adapted to all sections except the St. Lawrence River district and the more northerly portions of the Province.

Winter.

KING : Adapted only to the best apple sections, and succeeds best when top grafted on hardy stocks.
 HUBBARDSTON : Adapted to the best apple sections.
 GREENING : Adapted to the best apple sections.
 CRANBERRY : Requires good soil and is adapted to the best apple districts, but especially southern Ontario.
 BALDWIN : Succeeds best on clay land, and is adapted to the best apple districts.
 NORTHERN SPY : Adapted to the best apple districts, but can be grown with success further north by top grafting on hardy stocks. This is also a good method of bringing it into early bearing.

- ONTARIO : An early and abundant bearer, but short lived. Recommended as a filler among longer lived trees. Adapted to same districts as Northern Spy, which it somewhat resembles.
- STARK : Adapted to best apple districts.

VARIETIES VALUABLE FOR HOME USE.

Summer.

- YELLOW TRANSPARENT : Adapted to all sections.
- PRIMATE : Adapted to best apple sections.
- SWEET BOUGH : Adapted to best apple sections.
- DUCHESS : Adapted to all sections.

Fall.

- CHENANGO : Adapted to best apple sections.
- GRAVENSTEIN : Adapted to best apple sections.
- WEALTHY : Especially adapted to northerly sections.
- MCINTOSH : Especially adapted to northerly sections.
- FAMEUSE : Especially adapted to northerly sections.
- BLENHEIM : Adapted to best apple sections.

Winter.

- KING : Adapted to best apple sections. Should be top grafted.
- WAGENER : Adapted to best apple sections.
- SWAYZIE POMME GRISE : Adapted to all sections except most northerly.
- GREENING : Adapted to best apple sections.
- TALMAN SWEET : Adapted to best apple districts.
- NORTHERN SPY : Adapted to best apple districts, but will succeed farther north if top grafted.
- MANN : Adapted to best apple districts, but will succeed farther north if top grafted.

HARDY VARIETIES RECOMMENDED FOR SECTIONS NORTH OF LATITUDE 46 DEGREES.

- Summer : Yellow Transparent, Charlamoff.
- Fall and Winter : Duchess, Wealthy, Hibernial, Longfield, Patten's Greening, Whitney Crab, Hyslop Crab.

LOCATION AND SITE.

The large inland lakes surrounding the southern portion of this Province have a wonderfully ameliorating effect upon the climate for some distance from their shores, and as a rule, our most extensive commercial orchards are in proximity to these large bodies of water. There are, however, in the interior many localities quite as favorable for fruit growing, but in such locations the question of site and exposure

has to be more carefully considered. The site usually selected for the orchard is one near the buildings, which may be all right if these are on the highest ground, for such grounds are not only best drained but are least liable to untimely frosts. Good atmospheric drainage is often quite as important as good water drainage, and cold air like cold water runs down hill. Only a few feet of elevation above a wide adjoining area may be sufficient to enable trees in full bloom to escape a frost which destroys the crop on the lower level. On level lands there is practically no atmospheric drainage and the orchardist must take his chances and make the best of it.

EXPOSURE.

Where the land is rolling, and there is a choice of exposure, the situation should be carefully considered, for in many cases this may be the difference between success and failure. As to which is the best exposure, depends largely upon the surroundings. In proximity to large bodies of water the best exposure is toward the water. In localities subject to late spring frost the safest exposure is toward the north, as this helps to retard the period of bloom till danger of frost is past. On a northern exposure trees are less likely to suffer in times of severe drouth, and there is also not so much injury from sun scald, a most serious trouble in northern localities. For the reasons given a northern or eastern aspect is, as a rule, preferable to a southern or western one, and also because there is less exposure to our strongest prevailing winds, which come from the south west.

WINDBREAKS.

Protection from the prevailing winds is another matter that requires due consideration. The shelter accorded by a high hill or natural belt of timber is perhaps the ideal one, but when these do not exist, the planting of a windbreak is necessary. Prof. L. H. Bailey in his excellent book "Principles of Fruit-growing," thoroughly discusses the advantages and disadvantages of windbreaks, and summarizes as follows :

"The benefits derived from windbreaks are the following : Protection from cold; lessening of evaporation from soil and plants; lessening of windfalls; lessening of liability to mechanical injury of trees; retention of snow and leaves; facilitating of labor; protection of blossoms from severe winds; enabling trees to grow more erect; lessening of injury from the drying up of small fruits; retention of sand in certain localities, hastening of maturity of fruits in some cases; encouragement of birds; ornamentation."

"The injuries sustained from wind-breaks are as follows : Preventing the free circulation of warm winds, and consequent exposure to cold; injuries from insects and fungous diseases; injuries from the encroachment of the wind-break itself; increased liability to late spring frosts in rare cases.

"The injury from cold, still air is usually confined to those localities which are directly influenced by large bodies of water, and which are protected by forest belts. It can be avoided by planting thin belts.

"The injury from insects can be averted by spraying with arsenical poisons.

"The injury from the encroachment of the wind-break may be averted, in part at least, by good cultivation, and by planting the fruit simultaneously with the belt. So far as practicable, the wind-break should be planted as a distance of six rods or more from the fruit plantation."

The best trees for wind-breaks are some of the evergreens, such as Norway and White Spruce, the Austrian and Native White Pines. The Norway Spruce is most used because it is a rapid grower, and the young trees may be obtained very cheaply. The wind-break should be planted at the same time as the orchard, it will then be effective by the time the trees come into bearing. A single row may be sufficient, although in very exposed places, a double row, with the trees set alternately, is preferable. The trees should be at least six or eight feet apart, and even ten or twelve feet is better when the trees grow up. The trees in the wind-break should be well cultivated, the same as the trees in the orchard, until they become well established. Neglect of this is the main cause of failure in setting out wind-breaks.

THE SOIL AND ITS PREPARATION.

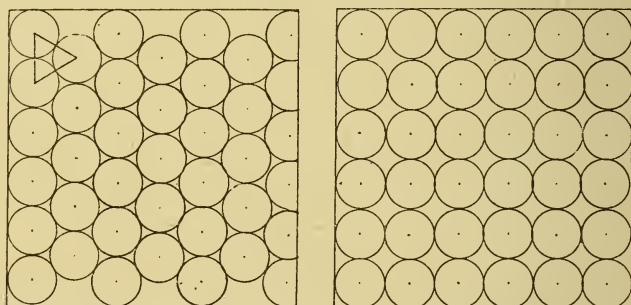
The apple tree readily adapts itself to a great variety of soils, yet there are certain kinds upon which it does much better than others. Light sandy soils are usually deficient in plant food, and are not retentive of it when fertilizers are applied to them. The trees upon such soils may do fairly well for a time, but as a rule they are less productive and shorter lived than on heavier soils. On the other hand, heavy clay soils may contain plenty of plant food, but they are difficult to work and unless very carefully managed bake so hard that the tree will not thrive upon them. The ideal soil is a happy mean between these extremes, a friable loam. It may be called a sandy or a clay loam, as either sand or clay predominates in its composition, and is all the better if of a limestone formation upon an open subsoil.

One of the first requisites in a good orchard soil is good drainage. Fruit trees will not thrive upon undrained soil. If the land is not naturally well drained, it should be thoroughly underdrained.

Good preparation of the soil previous to planting is very essential. Trees set on unprepared soil are seriously handicapped at an important stage of their life and often they never overcome it. Land which has been exhausted by grain growing is in poor condition for the growing of trees, although it may greatly improved by growing and plowing down two or three crops, such as rye, clover, or vetches, as a green manure. Probably no other crop leaves the ground in better mechanical condition for the growth of trees than clover. Its roots penetrate the soil deeply and leave it well filled with vegetable-matter or humus.

There has been much diversity of opinion regarding the value of subsoiling in preparing the land for trees. But there is little room for doubt that it is of much benefit on land where the subsoil is hard and impervious to water. The subsoiler should follow in the furrow of the ordinary plow, loosening the subsoil as deeply as possible. Where this is not done, clover roots are the next best thing as subsoilers.

The preparation of the ground for planting should begin by a good deep plowing in the fall, and it would be all the better if it could be ribbed up as is now frequently done in preparing ground in the fall for spring seeding. This insures good surface drainage and quick drying of the ground in the spring. All that would then be required in the spring would be to harrow down the ridges and loosen up the ground as deeply as possible with a spring tooth cultivator.



Hexagonal.

Square.

A comparison of the hexagonal and square systems of arranging trees in the orchard.

ARRANGEMENT OF TREES IN THE ORCHARD.

There are several methods of arranging the trees in an orchard. The plan usually adopted is that known as the square. By this arrangement the rows are planted the same distance apart each way, four adjoining trees forming a square. A more economical plan is what is known as the hexagonal arrangement, which admits of about fifteen per cent. more trees per acre without any more crowding. In the hexagonal arrangement the trees in one row are set alternately with those in the next, six adjacent trees forming a hexagon and enclosing a seventh in the centre.

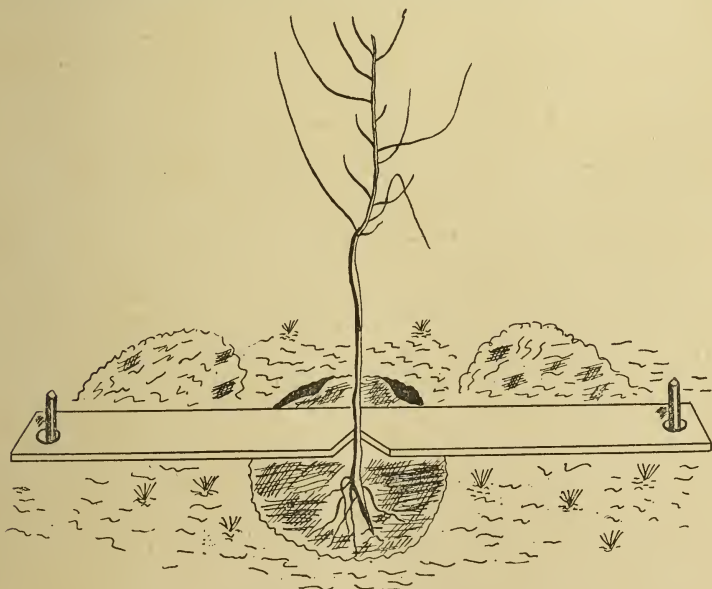
In laying out an orchard on the square, the first row is staked out at whatever distance the trees are to be apart, and at this same distance, the second and following rows may be staked out in the same manner.

In laying out an orchard on the hexagonal plan, after the first row has been staked at the desired distance, the position of the trees in the second row and also the distance apart of that and the following rows may be most easily found by taking two stout strings or wires, which after being fastened to any two adjacent stakes in the first row, are yet equal in length to the distance apart of these stakes, then drawing the free

ends out till they meet, forming an equilateral triangle. This being done at each end of the rows, the intervening trees may be located by measuring.

Whichever method of arrangement is adopted, the trees should be planted in rows as straight as it is possible to set them. Straight rows add not only to the appearance of the orchard, but to the convenience of cultivation. One of the best means of getting the rows straight is to stake out the position for each tree before beginning to plant. Laths are excellent for this purpose. Then when all has been properly staked out, a planting board should be used when planting to insure getting the tree in the exact position marked by the stakes.

A planting board is made of a light piece of board four or five feet long, with a hole bored through each end and a notch in the centre. It is well to have two or three of these made exactly alike, one for the planters and the others for those digging the holes. When a hole is dug, the notch in the planting board is placed around the stake, and wooden pegs are passed through the holes in the end of the board and left in the ground while the hole is dug and the board taken on to the next stake. The planters following place their board over the pegs and the tree in the notch in the centre. It will thus be in exactly the same position as the stake which previously marked the hole.



How the planting board is used.

DISTANCE APART FOR PLANTING.

The proper distance apart for planting depends altogether upon the ultimate size which the trees may attain, which in turn depends upon the

variety, the soil, and the locality. The varieties grown in our most northern orchards seldom spread more than twenty or twenty-five feet. While the kinds grown in the more favored apple sections of Southern Ontario often have a spread of forty feet. The best guides to intending planters is to observe carefully the distances required for full grown apple trees in the neighborhood. In southern Ontario this will be found to be from 35 to 40 feet, throughout central Ontario 30 to 35 feet, while in northern sections where only the hardiest kinds are grown 25 feet will be found quite sufficient. It is wise to allow plenty of space, so that there will be no crowding when the trees have reached their full size. Planting too close is a far more frequent and serious mistake than planting too far apart.

A plan quite frequently adopted, particularly in some of the large American orchards, is to use some of the small-growing early-bearing varieties, as fillers between the large-growing varieties. The Duchess, Ontario, and Ben Davis, for example, being planted alternately with large growing kinds, such as Baldwin, Greening, and Spy.

In such cases the large-growing kinds are set at the maximum distance apart, and the smaller kinds between them. By the time the larger kinds begin crowding, the smaller ones will have paid for their keep and that of the others and can be cut out to make room for the larger trees. The greatest objection to this plan is the danger that the fillers may be left so long before they are removed that the value of the whole orchard may be impaired.

ORDERING AND OBTAINING TREES.

A complete list of the nurserymen of this Province is published each year in the Report of the Inspector of Fumigation, and most of our leading nurserymen advertise in the agricultural and horticultural papers. Upon application, any of these men are glad to quote prices at which they can supply stock.

It is well, when ordering nursery stock, to order early. Too many leave such a matter till planting time, when they might as well have had their order in several months sooner. By ordering early they are more likely to obtain just what is wanted, and if the nurseymen has not the desired varieties on hand, he can obtain them elsewhere by the time they are needed.

When the trees arrive from the nursery, it is best to unpack them as soon as possible, and, if it is not convenient to plant them at once, the roots should be spread out and buried in a deep trench till they can be permanently planted. The longer the trees are to remain in this position the more carefully they should be heeled in.

TRANSPLANTING.

There is a diversity of opinion as to the best time for transplanting. It may of course be done any time when the tree is dormant, either

in the spring or autumn. In favorable localities and with hardy varieties it may be done quite as well one season as another, but for general planting the spring is the safest time in our rigorous climate.

Great care should be taken to prevent the roots of the trees drying while they are out of the ground. If it happens to be hot and windy at the time of transplanting, it is a good plan to puddle the roots in soft mud as soon as they are taken from the packing box or trench, and in carrying the trees about the orchard, it is well to keep the roots covered with a wet blanket or piece of old carpet.

The hole for the tree should be wide enough to hold the roots without cramping or crowding, and should be deep enough to admit of a few inches of fine mellow surface soil being filled in the bottom, and still have the roots an inch or two deeper than they were in the nursery row. The roots should be spread out in their natural position and should be covered with moist mellow surface soil. It is well, in digging the holes, to have the surface soil placed at one side and the subsoil on the other, so that in refilling the surface earth may be placed next the roots and the subsoil left for the top. If the soil has been properly prepared it is seldom necessary to water the roots at the time of transplanting, but care must be taken to ensure the soil moisture from below coming up to the roots. This is insured by tramping the earth firmly as soon as the roots are well covered, and leaving only the top soil untramped to act as a mulch and retain the moisture below. The neglect of this firming of the soil around the roots is one of the most common causes of failure in the transplanting of trees. If watering is necessary, a small pailful poured in as soon as the roots are nearly covered, is of more use than a half dozen on the surface after the planting is done.

All torn, bruised, or injured roots should be cut back, with smooth cuts, to sound wood. Smooth cuts callous over quickly and new roots are the more readily sent out. Trees obtained from the nursery, no matter how carefully they may have taken up, have lost the greater part of their root system, and in order that they may make a satisfactory growth when transplanted the top must also be cut back to a similar extent to restore the balance. This cutting back, however, can be most satisfactorily done after the trees are planted, when they are held firmly by the soil and more careful attention can be given to shaping the head of the young tree.

INITIAL PRUNING.

Closely associated with the heading back of the top at the initial pruning of the tree, is the question of determining the height at which the head should be formed. On this, as in many other points of orchard management, there is a variety of opinions. Some prefer high heads, because of the greater convenience for cultivation and working underneath; while others prefer them low, because of the greater convenience in pruning, spraying, and harvesting. There are other reasons, however, why low headed trees are preferable; in exposed locations the trees

and crop are less likely to suffer from violent winds, and in northern localities the trees with short trunks and low spreading branches are much less subject to injury from sunscald, the most serious tree trouble of the north. At the Algoma Fruit Experiment Station it has been found advisable to start the head not more than a couple of feet from the ground, while in the more favored sections the custom is to have at least four feet of trunk. This is the height at which the head is usually started on two or three year old trees as obtained from the nursery, and for this reason it is better for the northern planter to get two year old, rather than three or four year old, trees, so that he can start the head at whatever height he wishes. In this connection it may be stated that tree trunks do not lengthen, except by pruning off the lower branches, so that at whatever distance from the ground the lower branches are left, that will be the permanent length of the trunk.

Three branches are enough to leave to form the main limbs or framework of the tree top. These should be evenly spaced around the trunk to give a well balanced and symmetrical top, and they should also be placed on the trunk so as to distribute evenly the weight of the top and avoid bad crotches which are liable to split down with weight of crop. It is particularly important at this stage that great care should be taken to train the young tree in the way it should go, and much can be done in training and directing growth by heading back to buds pointing in the direction we wish the new branch to take.

CROPPING AND INTERPLANTING.

In a newly-planted orchard the trees occupy but a small portion of the land, and they cannot be expected to give any returns for at least five or six years. It is advisable, therefore, that some other crop be grown in the orchard which will pay for the labor spent upon it till the apple trees come into bearing and require all the space. It is by injudicious cropping, however, that young orchards are often most seriously injured. It should not be forgotten that the apple trees are the first consideration, and that whatever cropping is done in the orchard must not interfere with them in the least.

In some cases the spaces between the trees may be planted with small fruits, such as raspberries, currants, or gooseberries, but these should not be planted within nine or ten feet of the trees, nor should they occupy ground more than six or seven years.

Hoe crops, such as corn, roots, potatoes, etc., have generally been recommended as the best to grow in the orchard, because of the opportunity they afford for cultivation. This may be all right as far as it goes, but these crops draw heavily upon the plant food in the soil and return very little in the way of roots or plant residue. If such crops are successively grown for several years, they are almost sure to seriously deplete the soil of fertility, unless extra care is taken to maintain it by the application of manure or fertilizers. Probably on the whole the

least objectionable cropping is a well arranged rotation of crops, in which clover and hoed crops alternate frequently enough to keep the ground in good condition. Some of these crops harbor mice, and whenever such occur in the rotation precautions must be taken at the approach of winter to protect the trees from their ravages.

During all this intercropping a strip must be left in which the trees are growing for regular cultivation, and this strip should be widened each year as the trees increase in size. No cropping should be attempted under the head of the trees, and intercropping should be discontinued as soon as the trees require all the space.

CULTIVATION.

It is only during the last decade that the cultivation of the orchard has been considered a problem worthy of special attention by the great majority of Ontario fruit-growers. Even yet many have not abandoned the old practice of leaving the orchard in sod. At nearly every meeting of the farmers and fruit-growers someone asks the question : "Which is the best, sod or clean cultivation with cover crops ?

Cultivation improves the physical condition of the soil by breaking up the soil particles and presenting a greater feeding surface to the roots. By warming and deepening the soil, it permits of a greater depth of feeding area. Every soil particle is surrounded by a thin film of moisture, consequently the finer the soil particles the greater the surface area to hold moisture. A dry earth mulch or dust blanket on top checks the evaporation of moisture from below. Cultivation renders plant food more readily available by promoting nitrification and the decomposition of organic matter in the soil.

Knowing this to be the case, many growers have given the new system a fair trial, and have satisfied themselves that for most sections of Ontario clean cultivation with cover crops is more profitable than sod. There are indeed few cases where sod is more desirable than cultivation; these are where the soil is fertile and contains an abundant supply of moisture.

As soon as possible after the trees are set, a strip on each side should be cultivated to loosen up the soil which has been tramped down during planting. Each year this strip should be widened, so that no crop intended for harvesting is grown beneath the branches of the trees.

Cultivation should begin as early as the ground is dry enough in the spring. The first tool to be used in most cases is the plow. It is well to plow the land about five inches deep during the first few years after setting to encourage deep rooting. As the trees get older the depth of plowing should be gradually lessened, until by the time the orchard is in full bearing three to four inches is sufficient.

It is a good practice to roll each evening what has been plowed during the day, particularly if the ground is inclined to be lumpy. The soil is much more easily pulverized when freshly plowed than if allowed to lie exposed to the weather for several days.

Cultivate with the disc harrow or other cultivator soon after rolling to form a dry earth mulch, which prevents the loss of moisture by evaporation. Subsequently cultivation should be given as soon as possible after every rain, and about every two weeks in dry weather to maintain an effective dust mulch. These latter cultivations may usually be performed by means of light harrows. If weeds and grass get a start, the spring-toothed cultivator with the broad points should be used to cut them off. Cultivation should be continued until about the middle of July or the first of August, by which time the trees should have practically ceased growth. Cultivation after the first of August has a tendency to cause late growth of wood, which will not have time to properly mature and is liable to be killed back during the winter. If trees are making very rapid growth, it may be desirable to cease cultivation even earlier than the middle of July in order to check the growth. At the time of the last cultivation a cover crop should be sown.

COVER CROPS.

What is an orchard cover crop? It is a crop sown on the ground at that season of the year when trees have ceased their growth. If man makes no effort to cover the ground, nature forms a cover of weeds and grass in her endeavor to protect the soil.

Cover crops may benefit in many ways, of which the following are some of the most important: (1) A cover crop, by adding a large amount of fibre to the land, prevents hard soils from cementing or puddling. (2) On bare and rolling land, where the rains quickly run off and snows blow off the high portions, a growing crop tends to hold these until they have time to soak into the soil. (3) Land covered by a growing crop dries out more quickly in the spring, owing to the transpiration of moisture through the leaves, and consequently may be plowed under earlier in the season than land which is bare. This is a very important point as it enables the orchardist to gain several days in the busy season of spring. (4) Ground covered with vegetation will hold the snows in winter and thus prevent deep freezing, thereby avoiding the liability of root killing. (5) A cover crop affords the most economical means of furnishing a supply of humus in the soil. (6) The roots of a cover crop assist the tree roots in rendering available certain mineral plant food in the soil. (7) A large amount of plant food is liberated in the soil after the tree growth has ceased. This is taken up by the growing crop and held in a readily available form for the following season. (8) Leguminous crops, such as clover, vetch, alfalfa, peas, and beans, by virtue of certain bacteria which form nodules on the roots, are able to assimilate nitrogen from the air. As nitrogen is one of the most expensive fertilizing elements, the value of this class of plants cannot be too highly appreciated.

Cover crops should be sown about the middle of July so that they may make a good growth the same season. It is also wise to check the

growth of the trees about this time, so that they may mature their wood before winter sets in. The thorough tillage which should have been practised up to this season, leaves the ground in the best possible condition to give the young plants a start. The crop should be plowed under as early in the spring as possible, and cultivation should begin at once. If the crop is large and the soil rather dry, this is imperative, as the large amount of vegetable matter turned under seriously interferes with capillary action and leaves the surface soil unduly dry.

That a cover crop may be of the greatest value, it should be capable of withstanding the winter and continuing its growth next spring. This, however, is not a necessity, as many of the ordinary crops which will not live through the winter are valuable for this purpose.

Different soils require different kinds of crops. This has led to a division of cover crops under several classes. The most important are the nitrogen gatherers, which through the agency of the nodules on the roots can make use of the nitrogen of the air. Such plants as clover, vetches, alfalfa, peas, and beans, belong to this class, and should be used where the soil is deficient in nitrogen. Another class is known as the potash liberators, such as turnips and rape, which, although they do not add anything to the soil, as do the leguminous plants, yet change the form of the mineral potash so that it may be more readily acted upon by the roots of succeeding crops. Then there is a third class, commonly grown, such as rye, oats, and buckwheat, which are valuable chiefly on account of the humus formed by their development.

During the past two seasons, a number of the most common cover crops have been grown in the College orchard with a view to ascertaining their relative values. Among the most promising are the following:

Hairy Vetch, sown at the rate of thirty-five pounds per acre, forms a very close mat over the ground. This is a valuable crop owing to the fact that it collects nitrogen, lies close to the ground so that it does not inconvenience the pickers when gathering the fruit, and also withstands the cold winter and continues its growth early in the spring.

Red Clover and Mammoth Clover, sown at the rate of twenty pounds per acre, are about equal in value, make a fair growth, are low growing, and winter well on drained soil.

Crimson Clover has not made quite as good growth as the red or the mammoth, nor will it stand the winter here, which is a serious disadvantage.

Alfalfa, or lucerne, is one of the best leguminous crops for dry land. It makes a good growth and winters well. There is a mistaken impression that alfalfa will not make sufficient top the first season. Thirty pounds of seed per acre, sown in July, will give a good stand the same season.

Rape has given good results here. It makes a heavy growth of stiff stems, which, although nearly all killed in winter, stand up well

enough to hold the snows. Rape can scarcely be recommended for fruiting apple orchards, as it remains wet the greater part of the day, making the work of harvesting very unpleasant. It may be used to good advantage in the rotation, especially if few fruits are to be harvested.

Rye, the favorite crop of many growers, gives a fair amount of top and winters well. One advantage of rye is that it may often be grown on lands not in a physical condition for the growth of clover. In this way humus may be added to the soil, and conditions made more favorable for the growth of clover.

MAINTAINING FERTILITY.

The maintenance of fertility is more frequently neglected in the orchard than on any other part of the farm. Trees, even on poor land, will produce fruit, but it is only on soils where fertility is maintained that paying crops are produced. Each year that fruit is harvested some plant food is removed. If profitable crops are to be expected the supply of plant food in the soil must be maintained.

The most essential elements for the production of fruit are nitrogen, potash, phosphoric acid, and lime. Nitrogen encourages leaf and wood growth, which are essential to the development of the tree and to the production of the best quality of fruit. Potash is an essential constituent in the growth of fruits. It constitutes a large proportion of the ash of the wood and more than 50 per cent. of the ash of the fruit, and is also associated with the development of flavor in the fruit. Phosphoric acid is essential to the development of the tree and the proper ripening of the fruit. Lime is not in itself an essential element, but assists in liberating plant food. On a soil deficient in lime, growth often continues so late that the wood does not mature nor the fruit ripen properly.

Barnyard manure supplies nitrogen, potash, and phosphoric acid, and improves the physical condition of the soil. Cover crops may take the place of barnyard manure to improve the physical condition of the soil, and the leguminous ones may add all the nitrogen required. Concentrated fertilizers or commercial plant foods may be used in conjunction with cover crops to supply all the plant food necessary for the growth of trees. In the use of commercial fertilizers it is well to proceed cautiously, and, by carefully conducted experiments, ascertain what elements of plant food the soil may be deficient in, and what amounts it may be necessary to apply to get the best results. Unleached wood ashes contain a small quantity of phosphoric acid, seldom exceeding $1\frac{1}{2}$ per cent, a larger amount of potash, varying from 5 to 7 per cent., and also a certain amount of lime. Where pure wood ashes can be procured at a price not exceeding ten cents per bushel, they afford an economical source of

plant food. An application once in two or three years will usually give excellent results, especially on light soils which are most lacking in potash. Muriate of potash is another economical form in which to obtain potash. Phosphoric acid may be purchased in the form of superphosphate. Nitrogen may be procured in the form of sodium nitrate, but leguminous cover crops furnish a much cheaper source of this essential but costly element.

PRUNING.

The object of pruning is to form a vigorous and evenly balanced tree, which will produce annually a paying crop of good sized, well-colored fruit. Unpruned trees produce many small-sized unsalable apples. Pruning lessens the number of apples per tree, but at the same time increases the size and improves the quality of those produced. A heavy crop of good-sized fruit is not so serious a drain on the vitality of the tree, nor the fertility of the soil, as the same weight of smaller apples would be, for it is the production of the seed which makes the greatest drain on the tree and soil.

Pruning should be practised every year without fail from the time the tree is planted. In this way the operation is never a severe one, and the removal of the large limbs becomes unnecessary. Limbs growing too strongly in any particular direction, which are liable to upset the balance of the tree, should be headed back. Where two limbs cross, one of them should be removed. Branches growing across, from one side to the other, should be cut out. Care should be taken to leave sufficient twigs in the centre to protect from sunscald. Much may be done in directing growth by heading back to a bud pointing in the desired direction. It is while the trees are young that the greatest care in training is required.

A properly pruned apple tree should be open enough to admit sunlight and permit of free circulation of air. Its lower branches should be trained high enough to admit of easy cultivation, yet the top should not be so high that spraying and harvesting are rendered difficult. Varieties differ more or less in their habit of growth, and, while it may be advisable to modify this to some extent, it is not well to attempt to change it unduly. Long bare branches should be avoided, and the formation of fruit spurs should be encouraged on all parts of the tree.

The best time for pruning is just before growth begins. Wounds made at that season soon heal over. It is not well to prune when there is frost in the wood. Pruning while the tree is dormant tends to increase the growth of wood. Summer pruning encourages the formation of fruit buds, but it is not advisable to do much of it, as the removal of any considerable amount of the leaf area tends to check the vigor of the tree. Pruning by the removal of buds may be practised at any season of the year.

The thumb and finger may be used for the removal of sprouts and buds during the summer. A pair of small pruning shears will remove all twigs less than half an inch in diameter. For larger limbs a sharp fine-tooth saw is needed. Make all cuts as smooth as possible and close to the main stem. When a large limb has to be removed, it may be advisable to cut twice, the first some inches out to avoid splitting, and the second to shorten the stub. A common mistake is the leaving of long stubs which cannot heal over before rot begins. Where it is necessary to remove large limbs, the wounds should be covered with grafting wax or thick lead paint to prevent the entrance of spores which cause decay.

GRAFTING.

Grafting is the operation of inserting a scion into a stock, usually for the object of changing the variety of fruit produced. Trees bearing undesirable fruit may be top-grafted with some valuable variety. Many choice half-hardy varieties may be successfully grown by top-working on some hardy stock. Especially desirable characteristics in any variety may be perpetuated by grafting. Individuality is quite as marked in plants as in animals. A certain tree may possess some desirable quality, and this may be preserved and perhaps improved upon by selection. It is advisable when cutting scions to select from those trees which have the desirable characteristics most strongly marked. Nurserymen, as a rule, do not pay sufficient attention to the source from which they secure their scions. The individual orchardist may greatly improve his plantation by top-grafting with scions from a tree having the desired qualities most strongly marked.

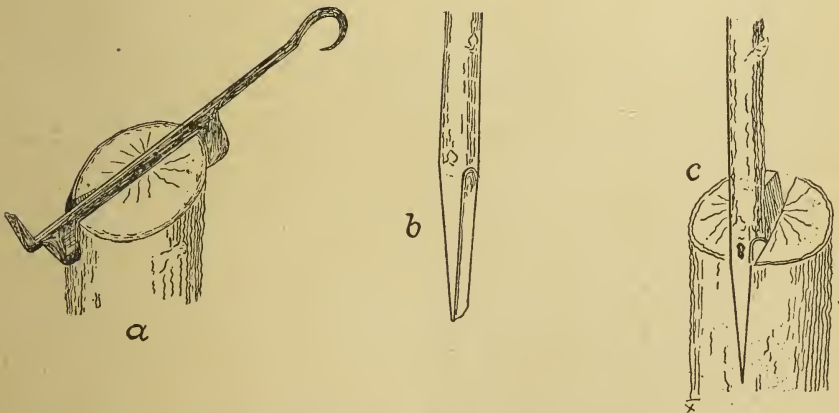
Grafting is usually performed in the spring. It is essential that the cambium layer of the scion and stock be in contact on at least one side. From this mucilaginous layer, lying between the wood and the bark, the new cells are formed which in time unite the parts and cover the wound. It is necessary to cover the wounds made in outdoor grafting to prevent the entrance of rot-producing spores. For this purpose wax is generally used.

A good grafting wax may be made by melting together four pounds resin, two pounds beeswax, and one pound tallow. Cool by pouring into a tub of water. Then work up into bars or balls which may be kept in any cool place until required. To economize wax, cloth is sometimes dipped into the hot wax, making wax-cloth. This is more difficult to use than pure wax. The wax may be melted and carried in a glue pot and applied with a brush, or as is more commonly done, it may be kept in water warm enough to keep the wax pliable so it may be readily applied by hand. It is well to keep the hands greased to prevent the wax from adhering to the fingers.

There are two common methods of top grafting. Whip or tongue grafting, which is practised upon small branches and young trees. Cleft grafting, which is usually performed on branches from one-half to two inches in diameter.



Whip grafting (a) scion and stock prepared, (b) same placed together, (c) tied.



Cleft grafting (a) splitting the stock, (b) scion, (c) scion inserted in cleft of stock.

In whip grafting the stock is cut with a bevel about one-inch long, and the scion cut to fit that bevel. Both bevels are cut into slightly and the tongue of one fitted into the notch of the other. The cambium layers must be in contact on at least one side. After the scion is set the wound should be covered with wax or similar substance to exclude the air.

Large trees should not be entirely changed over in one year. The first year select the main branches; the second year part of the remainder, and finish the third year. In this way much of the annoyance caused by the growth of water sprouts is avoided.



A handy grafting iron made from a blacksmith's old file.

When cutting off large branches for cleft grafting it is wise to cut twice, making the first cut a few inches above the position chosen for the scion. Then cut off the stub at the desired point, and avoid the danger of tearing the bark. With a chisel or grafting iron split the branch just far enough to admit the scions. Too deep a split weakens the stock, and the scions will not be held sufficiently firm. It is well to avoid grafting two horizontal limbs, one directly above the other. The tendency of new growth is upward, and the growths from the lower one will interfere with the upper. In branches, other than those growing perfectly upright, the split should be made parallel to, rather than at right angles to the ground.

The scion should be made wedge-shaped, with bevel about one inch long, starting at each side just at the base of a bud. Make the scion three buds long, cutting off just above the third bud. It should be cut a little thicker on the side next to the bud, so that the stock may pinch tightly on that side to insure a close contact of the cambium layers.

Open the cleft with the wedge end of the grafting chisel and insert one or two scions, as may be thought necessary. Place the lower bud of the scion to the outside. Do not force the scion down, but open the cleft by enough leverage on the chisel to admit the scion freely. Setting the scion with the top pointing slightly outward insures contact in at least one point. After setting the scions, cover all wounds with wax.

It is sometimes necessary to remove part of the water-sprouts, which usually start during the summer, to give the scions room for proper development. By the following spring the scions should have made sufficient growth to require all space in that part of the tree, and all other growth should be removed.

SUNSCALD.

Sunscald is an injury to trees which occurs most frequently in the northern districts. It is most serious on young trees, but may also

affect the upper side of the large branches in older trees. It is caused by the action of the hot sun on the trunk and branches in the early spring. The first indication is an unhealthy appearance of the bark on the south and southwest sides of trunk and upper side of large branches, the affected parts soon turn brown, then black, and finally die.

In districts where sunscald is apt to occur, it is well to head the trees low and incline the stem slightly to the southwest. In this way the branches afford some shade to the trunk. Anything which will shade the trunk in early spring will prevent the injury. For this purpose the most convenient of the following materials may be used : cornstalks, birchbark, building paper, or a veneer of thin wood, such as is used in basket making. The large branches of old trees should receive natural protection from the small branches and twigs of the top. For this reason severe pruning of the top is not advisable in northern districts.

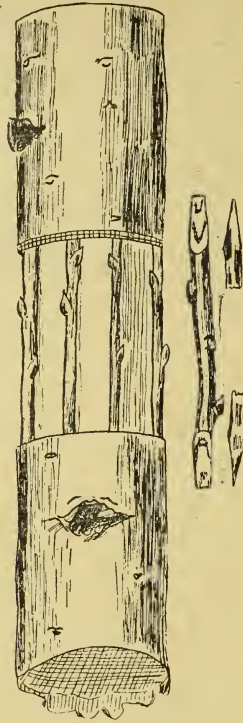
When trees are badly affected they usually die, but where the injury is slight, and is noticed soon after it occurs, treatment is practicable. Cut away the injured parts, and cover the wound with grafting wax or some material which will keep the wood from drying out. If the tree is healthy and vigorous, the annual growth spreading in from the sound parts soon repairs the injury.

PROTECTION FROM MICE.

During the past two or three years, mice have become a serious menace to young orchards. The rapid increase in numbers may be largely accounted for by the indiscriminate destruction of the farmer's best friends, the hawks, that feed largely on mice by day, and the owls, which take up the work by night. By carefully protecting the hawks and owls for a few years, their numbers will again increase, so that the equilibrium of nature may be restored. In the meantime something must be done to protect the trees against the rodents.

Mice seldom harbor in a green crop, and on clean fields they find no protection. They are found chiefly along the fence lines and in old meadows. As there is usually some shelter afforded the mice near orchards, it is advisable to guard against their depredations. In localities where the snow falls early and remains on the ground all winter, the simplest means of protecting the trees is to tramp the snow firmly about the base of each tree early in the winter. Where the ground is not continuously covered with snow during the winter, a mound of earth about the tree is sometimes all that is required to divert the runways of the mice. Building paper cut into strips which will reach about one foot high when tied about the trunk of the tree in autumn has been found to be both a cheap and an effective preventive.

TREATMENT OF INJURIES CAUSED BY MICE.



Bridge grafting.

Badly girdled trees usually die. When the part girdled is small and is covered before the wood dries out with grafting wax or other substance, which will protect the inner tissues the tree may be saved. If the girdled part extends entirely around the tree, it will be necessary to establish some connection between the cambium above and below the injury. This may be done by bridge-grafting. For this purpose use long scions cut to a bevel on each end. Insert one end above and the other end below the girdle, making sure that the cut surfaces are in contact with the cambium layer. A sufficient number of these scions should be put in to convey the cambium from the top to the roots and all cut surfaces exposed should be covered with wax.

PICKING.

Apples should be carefully picked by hand, without breaking the skin or bruising the fruit in any way. Summer varieties for immediate home use or special local trade should be allowed to ripen on the tree; but if intended for distant markets or storage they should be picked

when fully mature, but before they have commenced to mellow. Winter varieties should hang on the tree until they have reached full size and have taken on good color. Apples picked while still immature as a rule keep longer than if allowed to fully ripen on the tree, but they do not develop the full color nor the best quality. No sharp distinction can be made between green and mature, or between fully mature and over ripe fruit; one blends imperceptibly into the other. Experience teaches at what stage to harvest the crop, in order to secure the highest quality and best keeping properties in the fruit. Sometimes, with summer varieties, it is necessary to go over a tree twice, picking the most mature specimens first and leaving the remainder for a week or two in order that it may more perfectly develop. Round bottom baskets or pails should be used for picking, and it is better to have them lined with cloth to prevent bruising the fruit. Fruit should not be piled on the ground, but should be placed at once on the sorting table or be placed in boxes or barrels for removal to the packing house. The apple should be picked with the stem on but without breaking off the fruit spur, as is likely to occur if the fruit is picked too green. Spring waggons should be used to convey the fruit to and from the packing house.

When the trees have been properly pruned the fruit may all be harvested from ladders. A short step ladder is convenient for the under-side and low branches of the tree. For the upper branches light cedar ladders of suitable length will be found very convenient. Extension ladders have been praised very highly in the past, but as they are both awkward and cumbersome, practical growers are abandoning them. The practice of climbing through the tree to gather the fruit, and letting the baskets down to the ground by means of a rope, is out of date, and is not practised in commercial orchards. Inexperienced pickers often lose a great deal of time by not picking clean as they go, making it necessary to carry the ladder back and forth. Each time the ladder is moved all apples in reach should be picked.

PACKAGES.

A great deal of discussion has taken place during the past few years as to the best style and most suitable size of package. This depends somewhat upon the quality of the fruit and the requirements of the market. For summer varieties for local trade the ordinary eleven quart Climax basket is still the most popular package. For the export trade of XXX apples some prefer the box and others the barrel, depending on the market to be supplied and the relative cost of the two packages. Apples, other than early varieties intended for local markets, can usually be handled most cheaply in barrels.

The adoption of a standard size of box and barrel will have a tendency to establish confidence on the part of the buyer, and will eventually help the apple trade. The Standard barrel is defined in the Dominion Statute entitled Staple Commodities, I. Edward VII., Chap. 26, sec. 4 :

"All apples packed in Canada for export for sale by the barrel in closed barrels, shall be packed in good strong barrels of seasoned wood, having dimensions of not less than the following, namely :—twenty-six inches and one-fourth between the heads, inside measure, and a head diameter of seventeen inches, and a middle diameter of eighteen inches and one-half, representing as nearly as possible ninety-six quarts."

The standard box has just been established by the Dominion Government, and its use comes into effect on July 1st, 1906. The inside measurements are: 10 inches deep by 11 inches wide by 20 inches long, having a capacity of 2,200 cubic inches, or very nearly one-third of the standard barrel.

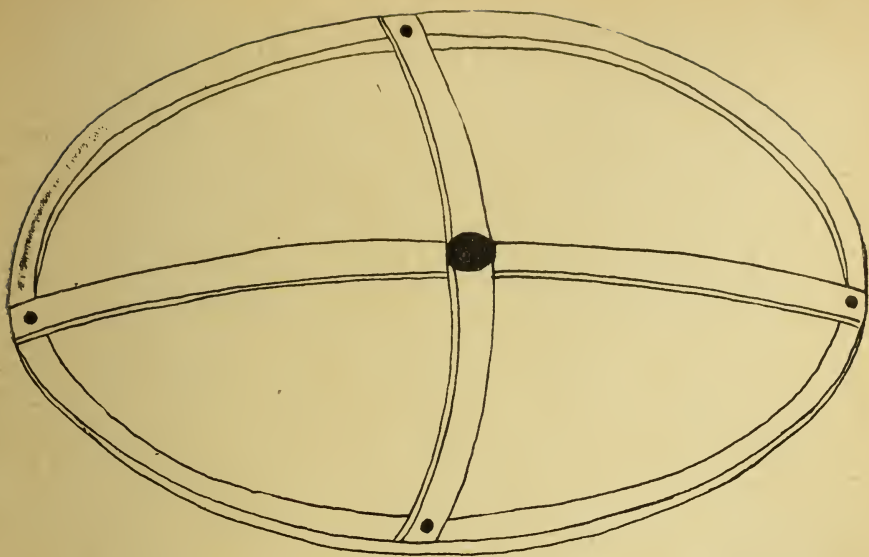
GRADING.

Apples should be carefully graded. Wormy, spotted, bruised, and misshapen specimens should be removed. It is usually well to make two grades of good fruit, differing only in size and color. Each grade should possess uniformity of size and color, and be free from defects. All fruit of one grade cannot be of the same size, but all the fruit contained in one package should be uniform. It is seldom advisable to export anything but XXX fruit, the XX and X fruit may be sold on the local markets or to the evaporators.

Mechanical graders may sometimes be useful in grading to size, but their use is not generally recommended. With a little experience, hand grading soon becomes a very simple operation. A thin board with holes the size of the various grades in which to try an apple occasionally assists in fixing the size in the mind. A basket should be provided for each grade, so that no fruit need be handled the second time.

PACKING.

Apples may be packed in boxes or barrels. If the barrel is used the hoops should be tightened and nailed, the head secured with liners and branded in accordance with the Fruit Marks Act, and the bottom end removed for filling. The first course of apples should be placed in concentric rows with the stems downward. Long stemmed varieties should have the stems clipped out. Some packers recommend placing the second course in by hand, but this is not necessary. The balance of the barrel may be filled by emptying direct from the basket. Be sure to let the basket well down to avoid bruising the fruit. After every two or three baskets the barrel should be racked to settle the fruit into place. To rack a barrel, place it on a plank and rock backward and forward once or twice. When one becomes accustomed to this work it is possible to settle the fruit quickly and effectively. With most varieties the barrel should be filled to about the top of the staves and levelled off evenly. At the last racking, in order to keep the apples from becoming displaced, it is a good practice to place on the top of the fruit, a false head covered with felt. Press the head carefully, tighten the hoops, nail on the liners, and the barrel is ready for market.



An excellent device for pressing the heads in apple barrels. The circle is a little smaller than the head of the barrel, and is made of iron, 1 in. wide and $\frac{1}{2}$ in. thick. The cross bars are made of heavy waggon spring steel. This enables the head to be put in place with the minimum amount of pressure on the head, and avoids bruising the fruit.

Packing in boxes requires more care than packing in barrels. For extra fancy fruit, it is well to line the inside of the box with fancy paper in order to present a better appearance when opened. Excelsior is often used in the top of the box, but it should be covered with paper to prevent the dust from settling among the apples. Place the first course by hand with stem end down. The remainder may be carefully poured in; but for the best results it is better to place all the fruit in layers, making sure that it is packed solidly. Place a piece of heavy paper on top of the fruit, press carefully, and nail the head on. If the fruit is properly packed it should require but little pressing to prevent the fruit from moving. The harder the fruit is pressed the greater the danger of bruising. Brand the box in accordance with the Fruit Marks Act. Always use stencils for branding. Pencil writing on a box is unsightly, and does not give the purchaser as good an impression as neat stenciling.

Some varieties, especially the softer ones, will bring better prices if each apple is wrapped in paper. The paper prevents the fruit from moving and becoming bruised and gives a finished appearance to the case. Only extra fancy fruit will pay for the additional cost of wrapping.

MARKETING.

In so far as commercial fruit growing is concerned, the business end of the enterprise, that of marketing the crop to the best advantage, is second in importance only to that of producing fruit of the best quality.

It is in this particular that there is the greatest need for improvement at the present time; just how the improvement shall be effected is more or less of a vexed question. There are scores of apple growers who have the skill to produce first-class fruit, while there are comparatively few who have the business ability to place it on the market when and where it will bring the best price. This is no doubt an argument in favor of the division and specialization of labor, whereby the grower confines his attention to the production of the fruit and the dealer to the buying and selling of it. But it has been this division of the work among buyers and handlers and sellers that has so divided the proceeds that there has been little or no profit left for the producer. The growers who make the most out of their apples are those who keep in as close touch as possible with the best markets both at home and abroad. During the shipping season these men watch the market reports daily, and unless prices are satisfactory they hold their fruit until good prices prevail. The great majority, however, of those who have apples to sell wait for some local buyer to come along, and sell for whatever he chooses to offer, either so much per barrel or a lump sum for the crop on the trees. The latter plan is little better than gambling, and at best is a hap-hazard way of doing business.

The only apparent remedy for this state of affairs, and the most promising means of putting the apple trade on a proper business basis, is for the growers in each apple growing section to unite to form a strong co-operative association through which the grading, packing, and marketing may be accomplished.

An effective co-operative association for this purpose, involves the selection of an honest, wide-a-woke, business manager, and the erection of a central packing and storage house at the most convenient point for shipment. Through such an organization boxes and barrels could be purchased wholesale to much better advantage; the grower could devote his whole attention to gathering the crop at the proper season and delivering it in good condition at the central packing house; the association would relieve him of all care and responsibility in grading, packing, and marketing; and with this work in the hands of expert packers, the grade would be uniform and the packing properly done, which would in time inspire confidence in the purchasing public. A good business manager could keep in close touch with the best markets and make sales when and where the fruit was most in demand. In short, consumers would be assured of a better product and growers would realize a better profit.

SHIPPING.

From the time the fruit is picked, until it is placed on the market it should not be exposed to sun, rain, or frost, nor should it be subjected to rough or careless handling, which it too often receives when given over to the tender mercies of the transportation companies; and this is

another particular in which a strong co-operative association would be more likely to affect improvement than individual shippers.

During the late autumn or winter months when the late keeping varieties are shipped, well ventilated cars or compartments on ship board afford the best means of transportation if precaution be taken against freezing. During the warm weather of the summer and early autumn when the early maturing varieties are sent to market, shipment in cold storage is advisable. Cold storage retards maturity and delays decay, but does not prevent it. Transportation in cold storage gives the best results when the fruit has been thoroughly cooled before being placed in the car or steamer for shipment. Herein, too, the cold storage at the central packing house provides this for every shipment which could not always be obtained by the independent shipper.

STORING.

The best keeping varieties of apples, when stored under proper conditions, may be kept the year round. The conditions necessary to the successful storage of apples are : a steady temperature, as near freezing as possible, without reaching that point; and an atmosphere moist enough to prevent wilting.

An ordinary house cellar usually furnishes the best place for the storage of the supply for domestic purposes. In such storage careful attention must be given to ventilation, as it is by this means principally that the temperature is regulated.

Before the fruit is stored it should be carefully picked over and all over-ripe, wormy, and bruised specimens should be culled from those intended for long keeping.

As there is always more or less risk in the storage of fruit, it is well for the grower who has apples to sell to hold the crop only so long as may be necessary to secure the best prices. For temporary storage in the fall a barn or other outbuilding may answer the purpose until severe freezing weather sets in. This is usually all the storing done by those who have but a small crop.

Where apples are grown or handled on a large scale, it pays to have a properly built fruit house, where the temperature and humidity inside can be controlled, and in which the crop may be held all winter if necessary. The walls of such a building are usually made of double thickness of matched lumber, with felt paper between and an air space between the studs. In such a house the crop may be packed and held for shipment as may be desirable any time during the fall or winter.

With the establishment of co-operative associations and central packing houses, the plan of the future will no doubt be central cold storage houses in connection with the packing houses, or at the points of shipment. In such houses the crop may be held under the most favorable conditions and put on the market whenever the demand warrants good prices.

APPLE ORCHARD CALENDAR.

- January :** Read best available literature on fruit growing. Attend Farmers' Institutes and work up co-operative organization. Make plans for new orchards. Order nursery stock.
- February :** Order or make up supply of boxes and barrels for next season's crop.
- March :** Prepare for spring work by getting in readiness plows, cultivators, spraying outfits and materials, pruning tools, etc. Get pruning done at earliest opportunity.
- April :** Plant out young orchards as soon as ground is ready. Do your grafting. Apply first spray of Bordeaux and Paris Green before buds start. Plow under cover crop as soon as ground is dry. Apply wood ashes or other fertilizers necessary.
- May :** Complete any of the above operations not finished last month. Repeat spraying before blossoms open. Follow plowing by surface cultivation.
- June :** Spray immediately after blossoms fall. Apply carbolic wash to trunks of young trees to prevent borers laying eggs. Continue surface cultivation to conserve soil moisture.
- July :** Repeat spraying for the fourth or fifth time, as may be necessary. Discontinue cultivation towards end of the month and sow cover crop as last cultivation. Thin fruit on young trees which may be overloaded.
- August :** Pick early apples intended for the market as soon as fully matured and well colored. Let hogs in the orchard occasionally to pick up early windfalls.
- September :** Begin harvesting autumn varieties as they mature. Get in touch with the leading apple markets if you have no co-operative organization to depend upon. Make an exhibit at your fall show, and study varieties there exhibited.
- October :** Continue harvesting of the winter varieties, taking them in the order of their maturity.
- November :** Watch market reports closely and ship promptly if quotations warrant good prices. Pack and store apples for further shipment or winter use. Protect trunks of young trees against mice, rabbits, or sun-scald as may be necessary upon approach of winter.
- December :** Continue apple shipments as may be necessary or advisable. Attend annual meetings of Fruitgrowers' Association and Provincial Fruit Show, and keep in touch with progressive fruit growers. Balance accounts for the year and decide upon lines of improvement for the next.

INSECTS INJURIOUS TO THE APPLE.

By WM. LOCHHEAD, B.A., M.S.

1. AFFECTING THE ROOTS.

THE WOOLLY APHIS OF THE APPLE (*Schizoneura lanigera*.) This insect is a small plant-louse with its body covered with a delicate, filmy cottony-like coat, which projects like a brush behind the body. It exists in two distinct forms, one inhabiting the roots and the other inhabiting the stems, the former being by far the more injurious. Throughout the summer the infested branches are very noticeable.

Galls and other enlargements arise on the affected roots, with the result that sooner or later death occurs. In the cracks which open up in the galls, the aphids live in clusters, and in a short time the vitality of the tree is very much reduced.

Treatment. Hot water, but little below the boiling point, when applied about the base of young trees in sufficient quantity to wet the soil to a depth of several inches, has been found to be effective and practicable. Tobacco stems, broken up finely and distributed about the base of the infested trees. The surface soil should be first removed, the tobacco applied, and the soil replaced. The roots of nursery stock suspected of bearing aphids should be dipped in a strong solution of tobacco stems, or in hot water (temp. 150 degrees F.) for a few seconds, or in hot soap solution, before the trees are planted.

III. AFFECTING THE TRUNK, TWIGS OR BRANCHES.

1. THE ROUND-HEADED BORER (*Saperda candida*). This borer is the grub of a brown beetle with two white stripes. It makes a round, oval tunnel in the trunk between the bark and the sapwood. At the end of the third year it changes to a pupa, which later changes into a winged beetle when it emerges. The eggs are laid on the bark in June and early July. The presence of this borer is betrayed by the sawdust-like castings at the opening of the tunnel, and by discolored bark.

Treatment. Probe or cut out the borer in fall and spring; apply to the trunk a white wash or carbolic soap wash before the first of June.

2. THE FLAT-HEADED BORER (*Chrysobothris femorata*). This borer has a large, flat thorax, and makes a wide oval tunnel. It is probable that the borer becomes mature in one year. The adult is a bronzy, greenish black beetle, about half an inch long.

Treatments. Same as for Round-Headed Borer.

3. THE BUFFALO TREE-HOPPER (*Ceresa bubalus*). A greenish insect, somewhat triangular in form, with an enormously developed prothorax, which projects in front into two horns. This insect does much harm by making slits in the bark, which open and form large oval scars.

The twigs and branches readily break at injured parts. The eggs are laid in the slits in July and August, and hatch the following June.

Treatment. Prune out affected branches and twigs in fall and spring.

4. OYSTER-SHELL SCALE (*Mytilaspis pomorum*). This brown scale insect infests the bark. It has a shape like a minute oyster shell. It passes the winter as an egg under the old scale. The egg hatches about the first of June, and there is but one brood each year.

Treatment. Spray trees with white wash, lime-sulphur wash, or whale oil soap solution in winter; spray with kerosene emulsion solution when the eggs hatch and the young are crawling.

5. SAN JOSE SCALE (*Aspidiotus perniciosus*). This insect is quite minute, is circular with a central nipple. It winters as a half grown scale and matures about end of June. There are three or four broods each season. It injures the tree by sucking the sap. If the presence of this insect is suspected, a report should be made to the Department of Agriculture, Toronto.

Treatment. Spray in spring before buds open with lime-sulphur wash.

III. ATTACKING THE BUDS AND LEAVES.

1. THE BUD MOTH (*Tmetocera ocellana*). The Bud Moth is a small, grayish insect which lays her eggs in July on the leaves. The young caterpillars feed on the under surface of the leaves. They pass the winter in a half grown state in small scales near the buds or other protected places. In spring they attack the swelling buds, often riddling them, and later form silken nests about the young leaves. The caterpillar is almost naked, brown with black head, and about $\frac{3}{4}$ of an inch long when full grown.

Treatment. Spray thoroughly with arsenic solutions just as the buds open.

2. FALL CANKER-WORM (*Anisopteryx pometaria* and the SPRING CANKER-WORM (*Paleacrita vernata*). The females of these moths are wingless, the former depositing her eggs on the twigs in the fall, the latter in the spring. The caterpillars of both species are loopers, which attain a length of an inch. They feed on the leaves. When full grown they descend to the ground and change to pupæ in earthen cells. The moth of the Fall Canker-Worm appears in the fall, while that of the Spring Canker-Worm appears in the spring.

Treatments. Band the trunks of the trees in early fall with burlap or cotton to prevent the wingless females from ascending to lay their eggs. Spray with arsenic solutions, usually just before or after blossoming, when the caterpillars are small.

3. THE TENT CATERPILLAR (*Clisiocampa Americana*). The web tents of these insects are often conspicuous in May, as the leaves appear. The caterpillar is hairy, and has a white-stripe down the back. The oval co-

coons are formed in protected places, and the yellowish-brown moths appear a week or so later to deposit bracelets of varnished eggs on the twigs. There is but one brood each season.

Treatment. Collect egg clusters in fall and winter; spray the young caterpillars with arsenic solution; burn or otherwise destroy the tents.

4. THE CIGAR CASE-BEARER (*Coleophora fletcherella*). Small cigar-shaped bodies may often be seen attached to the bark and leaves. These are the cases of tiny caterpillars which feed on the buds and leaves. In spring these caterpillars often do much harm. In late June or July the small moths appear to lay their eggs. When first hatched the caterpillars are leaf-miners, but later become case-bearers. They pass the winter in their cases, as half grown caterpillars.

Treatment. Spray thoroughly with arsenic solutions just as buds are opening and repeat if necessary a week later.

5. THE PISTOL CASE-BEARER (*Coleophora malivorella*). This Case-bearer is readily recognized by the pistol-shaped case which is attached to the branches. The small dark-colored moths appear at the end of June and deposit egg. The caterpillars hatch from the eggs in July, and eat holes in the leaves. They make cases for themselves as they feed. They spend the winter in the cases attached to the twigs. In early spring they recommence feeding on the opening buds and flowers. About the first of June they change to pupae, and the moths emerge two or three weeks later.

Treatment. Spray with arsenic solution as the buds are opening, and again a week later.

6. THE APPLE PLANT-LICE (*Aphis pomi et al*). These green plant-lice curl the leaves badly, and injure the buds. They are sucking insects and they secrete a sweet sticky liquid called honey-dew. They winter over as black, shining eggs on the branches of twigs. It is likely that there are more than one species. There are both winged and wingless forms during the summer.

Treatment. Spray when young plant-lice first appear with kerosene emulsion solution or any other good contact insecticide; spray with sulphur salt wash in early spring.

Several other insects are occasionally found injuring the leaves, viz., the APPLE-LEAF MINER, which mines within the leaf, and forms its pupa within the folded leaf; the APPLE-LEAF BUCCULATRIX, which forms white ribbed cocoons in clusters on the branches, while the caterpillars feed on the leaves; the PALMER WORM, a small yellowish green caterpillar, often numerous in June and July, when it injures the fruit as well as the leaves; the APPLE-LEAF TYER, which folds the leaf and lives within, feeding on the soft tissues; the APPLE-LEAF ROLLER, which feeds within folded leaves; the RED-HUMPED CATERPILLAR and the YELLOW-NECKED CATERPILLAR, which cluster on limbs and eat the leaves.

... *Treatment.* As a rule spraying with arsenic solution at intervals during the season will control these.

IV. ATTACKING THE FRUIT.

1. THE CODLING WORM (*Carpocapsa pomonella*). In the Eastern and Northern parts of Ontario there is but one brood, but in the South-western part there are two broods.

The small moths appear at the close of the blossoming period and deposit their eggs on the young fruit at the calyx end. The caterpillars bore into the fruit at the core, and when full grown, emerge and spin cocoons under the loose bark on the trunk in June and July, where they change into pupæ. Where there are two broods the moths appear in July and August to deposit eggs for a second generation. This brood of caterpillars may enter the half-grown apples at any point, but they emerge in the fall to form cocoons in which they remain hidden all winter. In spring they transform to pupæ, and later to moths just as the blossoms have fallen.

When there is but one brood the caterpillar after forming the cocoon remains in it until the following spring. The worms which fall to the ground with the apple make their way to some cover and form cocoons.

Treatments. Band the trunk with burlap or other suitable material about the tenth of June. Examine these bands every ten days or two weeks and destroy the cocoons which collect underneath; destroy the wormy and fallen apples; spray with arsenic solution soon after the blossoms have fallen; spray again in August to kill the young caterpillars of second brood.

2. THE APPLE MAGGOT (*Trypeta pomonella*). The adult of this Apple Maggot is a fly which deposits its eggs in the apple, and the maggots tunnel the fruit in every direction. They pupate in the ground or under any convenient cover.

Treatment. Prompt destruction of wind-falls. Spraying is not effective.

3. THE PLUM CURCULIO (*Conotrachelus nenuphar*.) This curculio does more harm in Ontario than the Apple Curculio. The fruit is often badly punctured and disfigured.

Treatment. Arsenical sprays will do much to control this insect, but so long as plum trees are uncared for, there will be much injury to apples.

4. GREEN FRUIT WORMS (*Xylina spp.*) There are several species of Green Fruit Worms. "There is but one brood in a year. They work mostly in May, pupate in the soil in June, live as pupæ during the summer and sometimes all winter, and most of the moths emerge in the fall and hibernate, laying their eggs in the spring." (Slingerland).

Treatment. Spray with arsenic solution before the blossoms open; cultivate ground in summer to kill the pupæ.

FUNGUS DISEASES OF THE APPLE.

I. ATTACKING THE FRUIT AND LEAVES.

1. THE APPLE SCAB (*Fusicladium dendriticum*, *Venturia pomi*). This fungus first appears on the leaves in smoky greenish patches, upon which sooty pear-shaped summer spores are produced. Later it appears on the fruit, where it develops under the cuticle or outer layer of the skin, and forms dark brown, or blackish spots. It appears to thrive best in cool, moist weather, and on closely crowded trees. The scab passes the winter on infected fallen leaves, as black bodies imbedded in the leaf tissues.

Treatment. Plow under the dead leaves; spray with copper sulphate before the buds open, with Bordeaux soon after the leaves unfold and every two weeks thereafter until the danger is over; and prune so as to prevent overcrowding and shading.

2. THE RIPE OR BITTER ROT (*Glæosporium fructigenum*, *Glomerella rufomaculans*). This disease is very prevalent in Illinois and other Central States. Brown spots appear on the half-grown apple, these gradually enlarge and run together forming irregular patches. Black points often arranged in concentric circles form on the diseased areas. Spores ooze from the black points, and are carried to other apples by wind and rain. The fungus winters over in another form in diseased apples, but a stage of the fungus winters over on cankered limbs, which are the main sources of infection.

Treatments. Thorough spraying with Bordeaux; the destruction of old diseased fruit; the removal and burning of cankered limbs.

3. THE BLACK ROT (*Sphæroopsis malorum*). This fungus produces a characteristic disease. The early mature apples when affected first, become brown, with black discolored spots under the skin, later become black, and finally shrivelled, shrunken and wrinkled. The spores are formed in the small pustules readily seen in the dried up fruit and in the leaves. Paddock of Geneva has shown that this same fungus often produces cankers on the branches, which have open wounds made by sunscald, etc.

Treatment. Spray with Bordeaux four or five times during the season at regular intervals, burn or plow under the diseased fruit and leaves, scrape and coat with tar or paint the cankers on the larger limbs and cut off and burn those on the smaller.

4. SOOTY OR FLY-SPECK FUNGUS (*Leptothyrium pomi*). This fungus injures mature apples under moist conditions, either in low moist ground or during a wet season. The popular names applied to this disease indicate quite accurately the character of the spotting of the fruit. Such varieties as Spy, Baldwin, and Greening are most susceptible to attack.

Treatment. Spray at regular intervals with Bordeaux, and select a high sunny position for orchard.

5. FRUIT SPOT (*Phyllachora pomigena*). This Fruit Spot has been quite common on Baldwins. It is recognized by sunken brown areas, which do not, however, sink very far into the flesh of the apple. The diseased spot has a bitter taste.

Treatment. Spray with Bordeaux.

THE POWDERY MILDEW (*Podosphaera oxyacanthae*). This fungus sometimes injures apple leaves. White patches appear on both surfaces of the young leaves, run together, and form a white felt. There are both summer spores and winter spores, but the disease is not hard to control, as it lives almost entirely on the surface of its host.

Treatment. Spray with Bordeaux at regular intervals.

THE APPLE RUST (*Gymnosporangium macropus*). This rust is peculiar in that it requires the red-cedar, as a second host, to complete its development. The so-called "cedar-apples" contain spores which may infect the leaves of apples and cause orange-yellow spots on the upper surface and scurfy bunches on the lower. The spores from the apple leaves in turn infect the red-cedar.

Treatment. Remove red-cedars if practicable and feasible.

II. ATTACKING THE STEM, ROOT, TRUNK AND BRANCHES.

APPLE TREE CANKERS These cankers are irregular, sometimes concentric, open wounds on the trunk, branches, or twigs. The bark is first destroyed by bruises or by sun-scald, and injurious fungous spores affect an entrance. It has been proved that cankers may be produced by (1) the *Bitter Rot* fungus, (2) the *Black Rot* fungus, and (3) the *Nectria*. The *Nectria* is not common in Ontario but the first and second species of cankers are too common.

Treatment. Remove and burn cankers on smaller limbs and twigs, and scrape and coat with tar or paint those on the trunk and larger limbs; protect the trunks of trees subject to sun-scald; spray for Bitter Rot and Black Rot.

CROWN GALL (*Dendrophagus globosus*). This slime fungus produces enlargements or galls on the roots near the surface of the ground. Such galls have been observed mainly on nursery stock in the United States. The disease has not yet become either dangerous or injurious in Ontario.

Treatment. Remove affected tree and burn.

1. TWIG, FIRE, OR. PEAR-BLIGHT (*Bacillus amylovorus*). This bacterial disease, so destructive to the pear, is also prevalent in apple orchards. The bacterium enters through the blossoms, and perhaps through wounds and insect punctures. As a rule, the terminal flowers, leaves, and twigs are first killed, the diseased parts appearing as if scorched by fire. The bark becomes black or brown, and the inner bark and cambium are destroyed. The disease travels backward into the branches, so that in time the entire tree may be killed. The injury is most marked in rapidly growing trees. It is believed that bees are the unconscious agents of infection

of the blossoms, as they have been seen to feed on the drops of a gummy excretion, containing multitudes of bacteria, which ooze from ruptures in affected twigs, and then to visit soon afterwards the blossoms.

Treatment. Cut off and burn affected twigs and branches whenever they appear. The limbs should be cut off 4 to 6 inches below the diseased part.

PREPARATION OF THE BEST INSECTICIDES AND FUNGICIDES.

I. Bordeaux Mixture.

Copper sulphate (blue stone)	4 pounds.
Fresh stone lime	4 pounds.
Water	40 gallons.

(1) Make a stock solution of bluestone by dissolving 25 pounds in warm water in a barrel and add water to make up to 25 gallons. Every gallon of this solution in first barrel contains one pound of blue stone.

(2) Into a second barrel put 25 pounds of fresh stone lime, and add with stirring small quantities of water to slake it. When fully slaked make up to 25 gallons by adding water. Every gallon of milk of lime in this second barrel contains one pound of lime.

To prepare the Bordeaux, empty 4 gallons of blue stone solution into the spray tank or barrel, which already should have 25 or 30 gallons of water in it; stir the milk of lime thoroughly and empty 4 gallons of it through the strainer into the spray barrel with constant stirring; then add water to make up to 40 gallons.

Any one of several arsenical compounds may be used along with the Bordeaux to form a combination insecticide and fungicide. The following are among the best :

(a) *Paris Green.* Add 4 to 6 ounces to 40 gallons of Bordeaux.

(b) *Arsenite of Soda.* Boil together for 15 minutes one pound white arsenic, 4 pounds sal soda, and 2 gallons water, until a clear solution is obtained. Add 1 to 1½ quarts to 40 gallons of Bordeaux.

(c) *Arsenite of Lime.* Boil together for 45 minutes 1 pound arsenic, 2 pounds fresh lime, and 1 gallon of water. Add one quart of this solution to 40 gallons of Bordeaux.

II. The Lime-Sulphur Wash.

Fresh Stone Lime	20 pounds.
Sulphur (flowers)	15 pounds.
Water	40 gallons.

With warm water make the sulphur into a paste; put in the lime and add about 15 gallons warm water with stirring. The Sulphur made into

a paste may be added after the lime has been slaked. Boil for an hour and a half in a kettle or in a barrel with live steam. Make up to 40 gallons; strain into spray tank and apply while warm.

Other lime-sulphur washes, made without the addition of external heat, are being tested, but their effectiveness has not been definitely ascertained.

III. Kerosene Emulsion (For Bark-Lice and Plant Lice).

Hard soap	$\frac{1}{2}$ pound, or soft soap 1 quart.
Boiling water (soft)	1 gallon.
Coal oil	2 gallons.

After dissolving the soap in the water, add the coal oil and stir well for 5 to 10 minutes. When properly mixed, it will adhere to glass without oiliness. A syringe or pump will aid much in this work. In using, dilute with from 9 to 15 parts of water. Kerosene emulsion may be prepared with sour milk (1 gallon), and coal oil (2 gallons), no soap being required. This will not keep long.

IV. Tobacco Decoction.

Refuse tobacco	2 pounds.
Water	5 gallons.

Boil the mixture for 30 minutes or more, until a dark brown tea-colored solution is obtained. Keep it covered until cool. It may then be used undiluted for spraying infested plants.

V. Whale Oil Soap.

For Plant Lice.—1 pound in 7 gallons hot water.

For San Jose Scale in Winter.—2 pounds in 1 gallon hot water applied as the buds are swelling.

VI. Crude Petroleum.

Undiluted crude petroleum may be used in late winter on apple trees for the San Jose Scale, but the trees should be dry, and no part should be sprayed more than once.

VII. Wash for Borers.

First, add soft soap to a saturated solution of washing soda to make a thick paint, then add 1 pint crude carbolic acid, and $\frac{1}{2}$ pound Paris Green to 10 gallons of wash.

To be applied to the trunks of apple trees in early June.

VIII. Lime Wash.

Slake $1\frac{1}{2}$ pounds fresh lime in 1 gallon of water. Strain the wash before spraying. To be applied during winter to trees infested with Oyster-Shell Bark lice.

Orchard Spraying.

Spraying is now generally practised by our best apple growers and the most successful growers are the firmest believers in the value of, and necessity for, *thorough, intelligent spraying*.

Thorough, intelligent spraying means (1) the use of a good spray-pump and outfit, (2) a knowledge of the enemies to be treated, (3) a knowledge of the remedies which have been found most effective, and their preparation, and (4) the proper time for the application of the remedies. It should be remembered that prevention of fungous diseases is possible, but their cure is hardly practicable.

The following spray Calendar for an apple orchard will be found very helpful to the grower who makes an honest effort to spray successfully.

A SPRAY CALENDAR FOR AN APPLE ORCHARD.

Application.	When to Spray.	Insects and Fungi Controlled.
Lime-wash	In winter	Oyster-shell scale, scurfy scale.
Lime-sulphur wash or Crude Petroleum	In early spring while trees are still dormant	San Jose scale, oyster-shell scale, and aphids.
1. Bordeaux, and Paris Green or other arsenical compound	Just as leaf-buds are expanding	Bud moth, case - bearers, scab, bitter-rot, black rot.
2. Bordeaux, and Paris Green or other arsenical compound	Just before blossoms open	Canker-worms, tent-caterpillars, bud-moth, case-bearers, etc., scab, bitter-rot, black rot.
3. Bordeaux, and Paris Green or other arsenical compound	Just after blossoms fall	Codling moth, cankerworms, tent-caterpillars, etc., scab, bitter-rot, etc.
4. Bordeaux, and Paris Green or other arsenical compound	Ten days or two weeks later	Codling moth, palmer worm, apple bucculatrix, curculio, scab, bitter-rot, etc.
5. Bordeaux, and Paris Green or other arsenical compound	Two weeks later—in July	Scab, bitter-rot, etc.
6. Bordeaux, and Paris Green or other arsenical compound	When second brood of Codling moths appears in August	Codling moth, scab, bitter rot.

BUTTER PRESERVATIVES.

BY H. H. DEAN, PROFESSOR OF DAIRY HUSBANDRY
AND R. HARCOURT, PROFESSOR OF CHEMISTRY.

Butter is composed of fat, water, curd, and a small amount of mineral matter. Fat is the most important constituent, and forms 84 to 87 per cent. of the butter. Butter fat is an extremely complex substance, composed of fatty acids in combination with glycerine. It differs from other fats, such as lard, tallow, etc., in that it contains a larger number of these glycerides. Besides the glycerides of the insoluble and non-volatile acids found in all fats, butter contains notable quantities of the glycerides of soluble and volatile acids. Some of these acids have a decidedly disagreeable odor, and, if by any means the glycerides containing these acids are decomposed, very strong rancid odors are developed. Furthermore, some of the fats are unsaturated compounds, which more or less rapidly combine with the oxygen of the atmosphere and thus set in motion changes which may not only destroy the pleasant aroma of good butter, but may also produce the disagreeable rancid smell common to bad butter.

The amount of curd in butter is not large, and, while it readily undergoes purtrifactive changes, does not appear to directly affect the keeping quality of the butter.* It serves, however, as food for the micro-organisms which cause the change and thus tends indirectly to produce bad flavors.

It is thus evident that the constituents of butter in their natural state are all delicate substances, some of which, or a combination of the whole, produce the peculiar aroma of good butter, and that the bad flavors are produced partly, at least, through the decomposition and oxidation of these substances. Most of these changes are doubtless due to the action of ferments which also produce compounds of an unpleasant nature. In addition to this, butter may have undesirable taints due to improper feeding of the cows, lack of care in treatment of the milk and cream, and to carelessness in the manufacture of the butter. Many of the faults of butter, due to these various causes, can be overcome. It is only by exercising the utmost care in every detail, from the production of the milk to the manufactured butter, that an article of the desired quality can be secured. But all butter, no matter how carefully it is made, will go "off flavor" in a comparatively short time.

*College Report, 1902, page 39.

The most common substance added to butter as a preservative is salt. The use of salt, together with the practice of storing butter in such a manner as to exclude air and light to prevent oxidation of the unsaturated fats, and at a low temperature to retard the action of ferments, has been, on the whole, fairly successful in retaining the good qualities of butter. In our export trade, however, new conditions are arising, and the dairyman has now to cater to a market which demands practically a saltless butter. To meet these new conditions he is compelled to cease using the only preservative with which he is familiar. Further, many creameries are not provided with cold storage plants, and are thus not able to use even this method of lengthening the commercial life of butter. Under these conditions it is not strange that butter-makers have commenced to use some of the brands of preservatives which are now so extensively advertised, especially when their use is advised by the wholesale dealers to whom they sell.

CHEMICAL PRESERVATIVES.

It is only in comparatively recent times that the real nature of fermentation, decay, and all such cases has been clearly understood. From time immemorial foods have been preserved by drying, smoking, placing in strong brine, in alcohol, or in vinegar, but it was not until after the work of Pasteur and others had shown that fermentation and decay are primarily caused by minute organisms, and that these organisms could not grow without moisture, in salt solutions, alcohol, or vinegar, that the true nature of these methods of preserving foods was understood.

Concurrently with the development of the science of bacteriology the study of chemistry has made known many chemical compounds which will destroy or retard the growth of these organisms. Many of these, such as bichloride of mercury, sugar of lead, etc., while powerful preservatives, are very poisonous, and for obvious reasons could not be utilized as food preservatives. In order to be used for this purpose, a substance must be almost without taste or smell, it must not be so noxious as to cause any immediate or serious results to the health of the consumer, it must be comparatively cheap, and yet so strong in its action on the lower organisms that only a small amount need be added to the food which it is desired to preserve. It is evident that the presence of small quantities of such substances in food would not be noticed by the consumer. In this they differ from the old preservative agents, such as sugar, salt, etc., which are condimentary in character, and reveal themselves by taste to the consumer.

At the present time the chief chemical compounds, other than salt, sugar, and alcohol, used in the preservation of foods are as follows:

1. Boric or boracic acid and borates.
2. Formalin or formaldehyde.
3. Salicylic acid.

4. Sulphurous acid and sulphites.
5. Benzoic acid or benzoates.
6. Fluorides.

The boron preservatives are apparently the most commonly used, and are preparations of boric acid and borax, with or without admixture of other preservative ingredients, such as salt, saltpetre, sugar, sodium carbonate, etc. They are used largely in milk, cream, and butter for preserving meat food generally, and to a smaller extent in beverages.

Formalin is a 40 per cent. solution of formaldehyde. As a preservative it is used chiefly in milk. In concentrated solutions it has a strong irritant odor, but when added to milk in quantities sufficient to retard fermentative action, it cannot be detected by taste or smell. The addition of formalin to milk is undoubtedly objectionable, as it interferes with digestion.

Salicylic, sulphurous, and benzoic acids and the fluorides are apparently used to some extent in dairy products, but more commonly in meat, fruit, vegetable preparations, beverages, etc. Salicylic acid is a powerful preservative, but it has a sufficiently characteristic taste to prevent it being used except in very minute quantities as a butter preservative.

Nearly all the preservatives now on the market are advertised as being "entirely wholesome," or that "its ingredients are all as healthful as salt," "capable of keeping the various articles of food perfectly sweet and fresh for any length of time, without the use of ice," etc. They are sold under a great number of fancy names, which, as a rule, give no clue to their real nature. On account of the perishable nature of foods, it is obvious that a substance having the properties claimed for the various commercial food preservatives would be of incalculable value. At the same time, we must recognize the fact that authorities differ as to the correctness of these claims, even for the boron compounds, which are possibly the least harmful of all the newer preservatives. While it would be very convenient to preserve foods by their use, it is important that nothing be added to foods which is toxic in itself, or which interferes even to the slightest extent with the process of digestion. This last point is especially important in dealing with the food of children and invalids.

The preservatives now in use may be divided into two classes: those which are undoubtedly injurious, such as formalin, the fluorides, salicylic and sulphurous acids, and those whose toxic action is disputed. The boron compounds belong to this latter class, and because of their extensive use in preserving dairy products, are of especial importance to dairy-men.

Numerous methods have been made to ascertain whether the use of boric acid or borax in small quantities was or was not injurious, but no definite conclusions have been reached. Many distinguished English, German and French scientists have performed elaborate experiments with

dogs, rabbits, guinea pigs, and human beings, and have come to opposite conclusions. The most elaborate experiment of this nature was recently conducted by Dr. H. W. Wiley, Chief Chemist of the Bureau of Chemistry, Department of Agriculture, Washington,* in which twelve young men, under close supervision, were given definite amounts of boracic acid and borax with their regular food. Dr. Wiley thus sums up the results of the effect of these preservatives upon the general health of the young men :

"The most interesting of the observations which were made during the progress of the experiments was in the study of the direct effect of boric acid and borax, when administered in food, upon the health and digestion. When boric acid, or its equivalent in borax, is taken into the food in small quantities, not exceeding half a gram (7 1-2 grains) a day, no notable effects are immediately produced. The medical symptoms of the cases in long-continued exhibitions of small doses, or in large doses, extending over a shorter period, show in many instances a manifest tendency to diminish the appetite and to produce a feeling of fullness and uneasiness in the stomach, which in some cases results in nausea, with a very general tendency to produce a sense of fulness in the head, which is often manifested as a dull and persistent headache. In addition to the uneasiness produced in the region of the stomach, there appear in some instances sharp and well-located pains which, however, are not persistent. Although the depression in the weight of the body and some of the other symptoms produced persist in the after periods, there is a uniform tendency manifested after the withdrawal of the preservative toward the removal of the unpleasant sensations in the stomach and head above mentioned."

"The administration of boric acid to the amount of 4 to 5 grams per day, or borax equivalent thereto, continued for some time results in most cases in loss of appetite and inability to perform work of any kind. In many cases the person becomes ill and unfit for duty. Four grams per day may be regarded then as the limit of exhibition beyond which the normal man may not go. The administration of 3 grams per day produced the same symptoms in many cases, although it appeared that a majority of the men under observation were able to take 3 grams a day for somewhat protracted period and still perform their duties. They commonly felt injurious effects from the dose, however, and it is certain that the normal man could not long continue to receive 3 grams per day."

"In many cases the same results, though less marked, follow the administration of borax to the extent of 2 grams and even of 1 gram per day, although the illness following the administration of borax and boric acid in those proportions may be explained in some cases by other causes, chiefly grippe."

"The administration of borax and boric acid to the extent of one-half gram per day yielded results markedly different from those obtained with

*Bureau of Chemistry, Department of Agriculture, Washington, Bulletin No. 84.

larger quantities of the preservatives. This experiment, Series V., conducted as it was for a period of fifty days, was a rather severe test, and it appeared that in some instances a somewhat unfavorable result attended its use. On the whole the results show that one-half gram per day is too much for the normal man to receive regularly. On the other hand it is evident that the normal man can receive one-half gram per day of boric acid, or of borax expressed in terms of boric acid, for a limited period of time without much danger of impairment of health."

"It is, of course, not to be denied that both borax and boric acid are recognized as valuable remedies in medicine. There are certain diseases in which these remedies are regularly prescribed, both for internal and external use. The value which they possess in these cases does not seem to have any relation to their use in the healthy organism except when properly prescribed as prophylactics. The fact that any remedy is useful in disease does not appear to logically warrant its use at any other time."

"It appears, therefore, that both boric acid and borax, when continuously administered in small doses for a long period, or when given in large quantities for a short period, create disturbances of appetite, of digestion and of health."

In 1899 the British Government appointed a departmental committee of experts to investigate the whole question of the use of preservatives and coloring matters in food.* This committee examined many witnesses, and certain members performed a large number of experiments. The conclusions arrived at by the committee relating to the use of preservatives in dairy products are of sufficient interest to be quoted here in full:

"The medical evidence, speaking generally, comprises for the most part opinion arrived at after a general consideration of the issues involved, but such opinion was not always based directly upon fact. The physiological evidence consists of the citation of the results of more or less exact physiological experiments. But, unfortunately, in the majority of cases the conditions under which the experiments have been made have only partially imitated those conditions which obtain in the actual taking of preservatives by the human subject to all ages for indefinite periods of time."

"Further, even supposing that we were to assume that the physiological experiments which have been laid before us did imitate with sufficient exactness the actual conditions obtaining in the inquiry in point, they would certainly do so only in so far as relates to the use of one preservative during a given period of time. The facts, however, show that in ordinary life what actually occurs is the simultaneous ingestion of more than one preservative. A further condition almost impossible of imitation by the physiological investigator is the consumption of these preservatives by all classes of invalids and by suckling. The absolute effect of these substances upon sucklings is at present unknown, and it is also

*Report of the Departmental Committee appointed to enquire into the use of Preservatives and Coloring Matters in the Preservation and Coloring of Food—1901.

practically impossible to infer with accuracy from facts at present ascertained what would be the effect of, for instance, formic aldehyde upon a patient suffering from uraemia."

"A factor still more subtle in its influence upon the question before us is idiosyncrasy. Certain individuals are extremely sensitive to certain drugs, and it appears that among these drugs must be reckoned at least one of the agents used as a preservative. Although legislation covering all possible idiosyncrasies would be too complicated to be practical; nevertheless, it must be pointed out that as matters are at present, an individual possessing idiosyncrasy with regard to the poisonous action of boracic acid would not be able to profit even by his own experience. For since the addition of this substance to foods is not declared he might be continually made ill by the repeated involuntary consumption of articles of food containing it."

"The actual material upon which to base trustworthy conclusions not existed heretofore, in that the declaration of preservatives, and also a regulation of and notification of the amount thereof present in any preserved food must be regarded as a necessary preliminary to any accurate observations or statistics upon the subject. Had declaration of preservatives been in force during recent years, we should probably now have been in possession of medical evidence more directly based upon fact than that which we have had laid before us."

"Notwithstanding the fact that trustworthy data as to actual injury are but few, there is evidence pointing to the probability that such injury does at times accrue. We cannot overlook the danger to which the uncontrolled use of drugs in the food of the population may be likely to give rise."

"Compounds of boracic acid have not been proved to be more hurtful than saltpetre to the consumer, yet saltpetre has been used from time immemorial in curing bacon, etc. The modern use of borax and boracic acid has enabled producers to dispense with a large proportion of common salt formerly necessary, thereby rendering bacon far milder to the palate, and protecting it from taint and fly-blow."

"After very carefully weighing the evidence we have come to the conclusion that as regards the trade in fresh and cured meat, fish, butter, margarine, and other food substances in the consumption of which but small quantities of the antiseptic are taken into the system, there exists no sufficient reason for interfering to prevent the use of boron preservatives. Even butter, of which the imports from all countries except Denmark frequently contain boracic acid, is not consumed in such quantities by individuals as to convey more than a very moderate daily amount of the drug into the system. The evidence satisfies us that the amount of preservative corresponding to 0.5 per cent. of boracic acid is sufficient for the purpose of preserving butter."

"But the circumstances and considerations affecting the milk traffic are very different. Milk, a very perishable substance, peculiarly liable

to bacterial contamination, forms a very large proportion of the daily food of the public. The nutrition of infants and young children depends greatly on the purity and abundance of the milk supply; and, seeing how frequently milk is prescribed for invalids and convalescents, it is of the utmost importance that it should not be the vehicle of any unsuspected agent. While it is possible that milk containing boracic acid in sufficient quantity to act as a preservative (say 30 grams to the gallon) might be consumed to the amount of four or five pints a day, without harmful results by most healthy children or adults, there is evidence pointing to an injurious effect of boracised milk upon the health of very young children."

"Moreover, there exists at present no guarantee against the addition of excessive amounts of preservative to milk. In 1896 the Medical Officer of Health of Birmingham estimated the amounts of boracic acid in a number of milk samples. Of these, one-half showed boracic acid in a proportion not exceeding 21 grains per gallon; in one-fourth the proportion varied between 21 and 42 grains per gallon; while in the remaining fourth it ranged from 42 up to 126 grains per gallon. Professor Blyth instanced a sample of milk, purchased in Marylebone, containing boracic acid in the proportion of no less than 80 grains to the pint. This occurred in December 1899, and the witness assured us that from time to time he had found an equally high proportion in milk samples taken in summer."

"Clearly such random use of any drug in a food calls for regulation. At present milk may be subjected to several successive treatments with preservative before it reaches the consumer. The farmer or producer sometimes applies it, so does the wholesale purveyor, so does the retail dealer; lastly, the domestic use of preservatives is increasing, and has become very general, and hence the milk may receive a fourth dose before it reaches the unsuspecting consumer."

"There is this further objection to the use of preservatives in the milk traffic, that they may be relied on to protect those engaged therein against the immediate results of neglect of scrupulous cleanliness. Under the influence of these preservatives milk may be exposed without sensible injury to conditions which otherwise would render it unsalable. It may remain sweet to taste and smell and yet have incorporated disease-germs of various kinds, whereof the activity may be suspended for a time by the action of the preservative, but may be resumed before the milk is digested"

The following are the recommendations of the committee which were based upon the conclusions they arrived at from their experiments and from the evidence brought before them:

"(a) That the use of formaldehyde or formalin, or preservatives thereof, in foods and drinks be absolutely prohibited, and that salicylic

acid be not used in a greater proportion than 1 grain per pint in liquid food and 1 grain per pound in solid food. Its presence in all cases to be declared."

"(b) That the use of any preservative or coloring matter whatever in milk offered for sale in the United Kingdom be constituted an offence under the Sale of Food and Drugs Act."

"(c) That the only preservative which it shall be lawful to use in cream be boracic acid, or mixtures of boracic acid and borax, and in amount not exceeding 0.25 per cent., expressed as boracic acid. The amount of such preservative to be notified by a label upon the vessel."

"(d) That the only preservative to be used in butter and margarine be boracic acid or mixtures of boracic acid and borax, to be used in proportions not exceeding 0.5 per cent., expressed as boracic acid."

"(e) That in the case of all dietic preparations intended for the use of invalids or infants chemical preservatives of all kinds be prohibited."

"(f) That means be provided either by the establishment of a separate Court of Reference, or by the imposing of more direct obligation on the Local Government Board to exercise supervision over the use of preservatives and coloring matters in foods, and to prepare schedules of such as may be considered inimical to the public health."

It is evident that Dr. Wiley and the British Committee agree regarding the harmfulness of even the boron compounds when taken into the system in large doses. But, while Dr. Wiley contends that the continued use of small amounts for a long period will "create disturbances of appetite, of digestion and of health," the British Committee concludes that "there exists no sufficient reason for interfering to prevent the use of boron preservatives when used in fresh and cured meat, fish, butter, margarine, and other food substances in the consumption of which but small quantities of the antiseptic are taken into the system." Dr. Wiley's conclusions were reached after a comparatively long study of cases under direct medical supervision; the Committee's conclusions were reached from experiments of much shorter duration, and from the fact that although preservatives were found to be used quite extensively, very few cases of sickness had been traced to them.

To gather further information on this point and to ascertain what effects the small amount of preservative commonly placed in butter would have on the system, it was suggested that experiments be carried on with the students in residence at the College. A table of twelve men, from 18 to 22 years of age and in good health, eagerly volunteered for the work. All they were asked to do was to use the butter provided regularly and to report if they felt the least pain or any unusual sensation develop. The butter prepared for this experiment contained one-half of an ounce of salt per pound and one-half per cent. of borax. For twenty-six days during the fall term the twelve men used practically three pounds of butter per day and would, consequently, have consumed, provided all preservative was retained in the butter about .5 grams of borax per

day. No ill effects were felt by any of the men. After the Christmas vacation the experiment was resumed, and, at the time of writing, has continued for fifty days, without any noticeable injurious effects. This experiment was not so accurately carried out as those of Dr. Wiley; it was intended only to test the effect of the preservative on the health of the men in a general way; but it tends to prove the conclusion arrived at by the British Commission.

On the other hand, while it is doubtless true that some, possibly the large majority of people may use boron preservatives without feeling any unpleasant effects, others may be seriously affected. Further, if preservatives of various kinds are used in a number of food substances and in beverages, it may happen that in the aggregate a large enough quantity be taken into the system to be harmful.

With the present available information regarding the effects of the so-called chemical preservatives on the human system, it is apparent that it would be unwise to recommend their use except in cases where the necessity is clearly manifest, and where it can be demonstrated that other methods of preservation are not applicable. Milk and cream certainly do not come under this list; for it has been abundantly demonstrated that with proper care these substances can be placed in the consumer's hands in good condition. Long experience has also proven that it not necessary to use preservatives in butter intended for home consumption. With export butter the case is somewhat different. It does not reach the consumer so quickly, and has to be shipped long distances, sometimes under very trying condition. Moreover, the trade demands a practically saltless butter, thus preventing the use of the preserving material used in the home trade. It is evident, however, that only boron preservatives should be used, and then in the smallest amount necessary to preserve the butter.

Another point that cannot be too strongly emphasized is that preservatives do not improve the butter; they simply preserve for a longer time the flavor developed in the fresh article. The flavor is influenced by many conditions in the production of the milk, care of the milk and cream, and in the manufacture of the butter, and is practically settled before the preservative is added. The preservative only helps to retain the particular flavor developed, and cannot be used to overcome slovenliness or carelessness in the manufacture of the butter.

During the last few years various brands of butter preservatives have been extensively advertised throughout the Province. Naturally, considerable interest is being taken in them, and many requests have come to us for exact information regarding their nature and use. To answer these questions more definitely, we decided to collect and examine a number of the commercial preservatives now on the market and to study their preserving or keeping properties when used in butter. The general plan of the work at the Dairy was as follows: The regular churning, which usually consists of 200 to 300 pounds of butter made

from pasteurized cream, was divided into several lots,—one for each preservative tested. The small lot of fresh butter was taken from the large "Success" churn and placed in a small "Simplex" churn for working. After placing the butter in the churn the preservative was sifted over the butter, and distributed as evenly as possible. The worker attachment was then put in motion and the butter was given the usual amount of working—18 to 19 revolutions of the worker. In those experiments where salt was used with the preservative, the two were weighed separately and then thoroughly mixed before adding them to the butter. All the different preservatives were plainly labelled and after weighing were placed on papers marked with the name of the preservative. The boxes and prints were numbered at the time and a record made of the preservative together with the distinguishing number so that there could be no mistake and no mixing of the different lots. Every known precaution was taken that each lot should contain the preservative intended for it and no other. In all the summer experiments, one pound print wrapped in parchment paper, and one 28 lb. box were marked and placed in the refrigerator for scoring. The boxes were lined with heavy parchment paper which had been previously soaked for at least 24 hours in a brine and formalin solution. Every precaution was taken to prevent mould or unnecessary deterioration of the butter. Four lots were made from ripened cream and two from sweet cream. In all cases the cream had been previously pasteurized at a temperature of 180 to 185 degrees F.

THE PRESERVATIVES.

The commercial preservatives were secured from the different firms or their agents. We wrote all the Canadian firms whom we could hear of as selling goods of this class in Canada. We explained the nature of the work we intended doing and asked them to send us a sample of their regular goods. Most of the firms cheerfully donated sufficient for our work. The borax, boracic acid and sodium fluoride were purchased from chemists. The salt was a portion of that from our regular supply.

Each of these preserving substances was submitted to a close chemical examination, the results of which are given below. The number of the chemical preservatives will be used to designate these substances hereafter.

No. 1 Commercial borax containing chlorine equivalent to 1.64 per cent. of sodium chloride or common salt.

No. 2. Practically pure boracic acid.

No. 3. A commercial preservative containing 3.75 per cent. of common salt, balance boracic acid with a small amount of borax.

No. 4. A commercial preservative containing 5.41 per cent. of common salt, 9 per cent. saltpetre, balance borax and boracic acid.

No. 5. A commercial preservative containing 6.5 per cent. of common salt, balance borax and boracic acid.

No. 6. A commercial preservative containing 10 per cent carbonate of soda, balance borax and boracic acid.

No. 7. Common salt, practically free from impurities.

No. 8. A commercial preservative containing 27.48 per cent. of common salt, balance borax and boracic acid.

No. 9. Practically pure sodium fluoride.

No. 10. A commercial preservative containing 1.60 per cent. of salt, balance borax and boracic acid.

Preservatives 8 and 9 were used only in September experiments. No. 10 was used only in December. The quantity was either one-quarter of one per cent. or one-half of one per cent. In the two experiments of July 26 and 27, one-quarter of one per cent. each of borax and boracic acid was used, and one-half per cent. of the commercial preservatives. When salt and preservatives were mixed, one-quarter of one per cent. of each was used. When salt alone was added the rate was 3-4 of an ounce per pound of butter or about 4 1-2 per cent.

THE TREATMENT OF THE BUTTER.

Immediately after the butter was worked and packed or printed, it was taken to an ice cold-storage where the temperature was about 40 degrees F. The lots made July 14, 21, 26 and 27, were scored the first time on July 30th. The July lots were scored the second time on September 13th and again, together with the September lots, on October 4th. All the July boxes and the boxes made on September 13th were taken out of the refrigerator and sent to Montreal on October 17th. They were placed in cold-storage on arrival at Montreal and were scored November 2nd, 1904, by Messrs. A. W. Woodard, official referee, Vaillancourt, Olive, Ayer, and LeClair. The samples were known to these judges by numbers only. It was not possible for them to know what kind of preservative had been used in the several packages.

THE JULY BUTTER SCORES.

As the flavor is of the most important quality in butter this was the chief point noted in the experiments. Unless something special was observed, no other point than flavor was judged. The Commercial Preservatives are indicated by number only. The same number will be given in all the scorings.

Preservatives.	Flavor 45. Av. First Scores.		Flavor 45 Av. Second Scores (45 days later).	
	Prints.	Boxes.	Prints.	Boxes.
1. Borax	41.6	41.5	41.7	37.7
2. Boracic Acid	42.0	41.5	41.0	36.2
3. Commercial Preservative....	42.0	41.6	41.5	35.5
4. " " "	42.1	41.6	41.5	37.5
5. " " "	42.1	41.3	41.7	37.0
6. " " "	42.0	40.8	41.2	37.2
7. Common Salt.....	42.2	41.2	37.5	35.2

It will be noticed that the lots of butter in pound prints seemed to have held their flavor for 45 days better than did the lots in boxes, although all were in the same refrigerator. The greatest depreciation was in the lots where common salt and No. 3 preservative were used, and the least in the cases of Nos. 1 or borax and 6.

ONE-HALF AND ONE-QUARTER OF ONE PER CENT COMPARED.

The maximum quantity of preservative recommended by the manufacturers is usually one-half of one per cent. In order to compare one-half and one-quarter of one per cent. and also 1-4 per cent. mixed with salt as to effectiveness in preserving butter, these two quantities were used in some of the experiments. The following table gives the average of the Montreal scores which were made on November 2nd, about 3 1-2 months after the first lots were made and six weeks after the making of the freshest lot.

Preservative.	Av. Scores for Flavor. Max. 45		
	$\frac{1}{2}\%$	$\frac{1}{4}\%$	$\frac{1}{4}\%$ pre. and $\frac{1}{4}\%$ salt.
1. Borax.....	40.2	40.5	36.7
2. Boracic Acid.....	34.5	39.5	37.5
3. Commercial Preservative.....	39.9	41.0	39.0
4. " ".....	38.8	41.0	39.7
5. " ".....	39.2	41.0	40.4
6. " ".....	39.8	41.7	39.2

The scorings indicate that one quarter of one per cent. of preservative is as effective as one-half of one per cent. under the conditions named, in fact the averages for flavor were higher in the lots to which one-quarter of one per cent. was added due no doubt to the fact that the lesser amount does not impart the "preservative flavor" which most of the judges commented upon, as will be seen farther on. The addition of one-quarter of one per cent. of salt to the preservatives appeared to lower the average scores,

RIPENED VS. SWEET CREAM BUTTER.

In order to compare the effects of the preservatives and salt on butter made from ripened and sweet cream the scores of the four lots made from ripened cream and of the two from sweet cream are given separately with the following average results in flavor for both prints and boxes.

Preservative.	Flavor 45 Ripened Cream Butter			Flavor 45 Sweet Cream		
	Dairy Scores	Montreal Scores	Average	Dairy Scores	Montreal Scores	Average
1. Borax.	40.7	39.7	40.2	41.0	39.5	40.2
2. Boracic Acid.	40.4	37.8	39.1	40.6	39.0	39.8
3. Commercial P.	40.3	39.9	40.1	40.8	40.0	40.4
4. " "	40.7	39.3	40.0	41.3	40.0	40.6
5. " "	40.6	39.7	40.1	41.1	40.0	40.5
6. " "	40.3	39.8	40.0	41.0	41.2	41.1
7. Salt	38.6	33.8	36.2	40.7	40.0	40.3
8*. Commercial P.	40.5	42.5	41.5	41.5	†	41.5
9*. Sodium Fluoride....	36.0	40.0	38.0	37.0	†	37.0

* Used only in Sept. expts.

† Not sent to Montreal.

Two points are brought out in these scorings.

1. The average for flavor was higher in the lots made from sweet cream both in the Dairy and Montreal scores. This was specially so in the samples where common salt alone was used.

2. There was not much difference in the average scorings for the different preservatives other than for salt and sodium fluoride, although the latter was given a comparatively high score at Montreal. It will also be noticed that the borax lots have averaged about the same as did those in which commercial preservatives were used.

One-quarter per cent. borax and one-quarter per cent. boracic acid, one-half per cent. commercial preservatives, and three-quarters of an ounce of salt compared. One experiment only.

Preservative and amount.	Flavor Max. 45	Flavor Max. 45	Flavor Max. 45
	Average Daily Scores	Av. Montreal Scores	Average Of All
1. Borax $\frac{1}{4}$ %	40.7	39.5	40.1
2. Boracic Acid $\frac{1}{4}$ %	40.2	39.0	39.6
3. Commercial P. $\frac{1}{2}$ %	40.5	40.0	40.2
4. " " $\frac{1}{2}$ %	41.2	40.0	40.6
5. " " $\frac{1}{2}$ %	41.0	40.0	40.5
6. " " $\frac{1}{2}$ %	41.0	41.2	41.1
7. Salt $\frac{3}{4}$ oz.	40.7	40.0	40.3

In this experiment preservative No. 6 seems to have given the best results, although there is not so very much difference in the average scorings of all the lots including salt. With the sweet pasteurized cream the salt appears to have given nearly as good results as the preservatives.

DETAILED SCORING OF THE LOTS SENT TO MONTREAL.

As previously explained, all the July lots and one of the September lots were sent to Montreal and were scored by the experts on November

REPORT OF SCORES ON BUTTER SENT TO MONTREAL AND SCORED, NOV. 2, 1904.

2nd. The following table gives the details of the scores together with the judges comments on each lot.

Sample No.	Kind of		Date of Making.	Score for Flavor, Max 45.					Av. of all.	Remarks of Judges:
	Cream.	Preservative in Butter.		Individual Scores.						
				(1)	(2)	(3)	(4)	(5)	Av.	
1	Ripe	1. Borax $\frac{1}{2}\%$	July 14	40	41	40	40	40	40.2	Irregular color, gritty, well kept, sweet, pre. flavor
8	"	Borax $\frac{1}{4}\%$	" 21	38	39	39	35	39	38.7	Oily, irregular color, gritty
15	"	Borax $\frac{1}{4}\%$	" 26	40	40	40	42	41	40.7	No taste, no smell, little oil.
22	Sweet	" $\frac{1}{4}\%$	" 27	40	37	40	40	41	39.5	Mouldy.
29	Ripe	" $\frac{1}{4}\%$	Sept. 13	41	42	39	45	40	41.4	Cloudy to mottled, beginning to mould.
2	Ripe	2. Boracic A $\frac{1}{2}\%$	July 14	37	32	30	30	39	34.5	Stale, fishy, gritty; pre. taste and smell.
9	"	Boracic A $\frac{1}{2}\%$	" 21	37	41	35	37	37	37.5	Fishy, poor.
16	"	" $\frac{1}{4}\%$	" 26	40	40	40	39	41	40	Slightly fishy, mouldy, trifle stale.
23	Sweet	" $\frac{1}{4}\%$	" 27	39	41	40	38	39	38.1	Mouldy, flavor not accountable for.
30	Ripe	" $\frac{1}{4}\%$	Sept. 13	37	42	41	38	39.5	Beginning to mould, even color.	
3	Ripe	3 $\frac{1}{2}\%$	July 14	40	33	39	40	42	38.7	Stale, sweet.
10	"	3 $\frac{1}{2}\%$ & $\frac{1}{4}\%$ Salt	" 21	39	39	38	40	41	39.9	Very little fishy, very little taste pre.
17	"	3 $\frac{1}{2}\%$	" 26	41	41	41	42	41	41.2	Mouldy.
24	Sweet	3 $\frac{1}{2}\%$	" 27	40	40	40	39	41	40	Very mouldy, gritty, very little foreign flavor.
31	Ripe	3 $\frac{1}{2}\%$	Sept. 13	41	43	36	42	43	41	Gathered cream, good.
11	"	4 $\frac{1}{2}\%$	July 14	35	41	30	37	40	36.6	Fishy, preservative smell.
18	"	4 $\frac{1}{2}\%$ & $\frac{1}{4}\%$ Salt	" 26	40	41	41	38	40	39.7	Slightly stale, very little smell and taste.
25	Sweet	4 $\frac{1}{2}\%$	" 27	39	40	42	40	39	40	Slightly fishy, very mouldy.
32	Ripe	5 $\frac{1}{2}\%$	Sept. 13	40	43	38	44	40	41	Very mouldy, gritty.
5	Ripe	5 $\frac{1}{2}\%$	July 14	38	41	32	40	42	38.6	Mottled color, beginning to mould, cooked taste.
12	"	5 $\frac{1}{2}\%$ Salt $\frac{1}{4}\%$	" 21	40	41	42	40	39	40.4	Slightly stale, inclined to be fishy.
19	"	5 $\frac{1}{2}\%$	" 26	39	40	40	39	38	39	Slightly fishy, gritty, stale.
26	Sweet	5 $\frac{1}{2}\%$	" 27	41	41	41	41	41	41	Spotted, woody flavor, mouldy.
33	Ripe	5 $\frac{1}{2}\%$	Sept. 13	41	42	40	41	41	41	Beginning to mould, a little gritty, preservative taste.
6	Ripe	6 $\frac{1}{2}\%$	July 14	40	41	42	41	40	41.4	Peculiar flavor, special taste.
13	"	6 $\frac{1}{2}\%$ Salt $\frac{1}{4}\%$	" 21	39	40	41	42	40	39.2	Fishy, mouldy, pre. taste.
20	"	6 $\frac{1}{2}\%$	" 26	38	40	40	38	37	37	Gritty, woody, poor color, beginning to mould.
27	Sweet	6 $\frac{1}{2}\%$	" 27	41	41	41	40	43	41.7	Good, good.
34	Ripe	6 $\frac{1}{2}\%$	Sept. 13	41	43	40	40	43	41.7	Fishy, no mould, stale.
7	Ripe	7. Salt $\frac{3}{4}$ oz.	July 14	35	27	29	32	37	32	Fishy, no mould, stale.
14	"	" $\frac{3}{4}$ oz.	" 21	35	36	29	35	35	34	No mould.
21	"	" $\frac{3}{4}$ oz.	" 26	35	33	33	37	34	35.6	No mould.
28	Sweet	" $\frac{3}{4}$ oz.	Sept. 27	38	41	39	40	42	40	No mould, well kept.
35	Ripe	8 $\frac{1}{4}\%$	Sept. 13	42	43	43	43	43	43	Too much preservative, gathered or old cream flavor, preservative taste.
36	"	8 Sodium Fl. $\frac{1}{4}\%$	" 13	41	41	41	36	41	40	

Judges: (1) Woodard, (2) Vaillancourt, (3) Olive, (4) Ayer, (5) LeClair.

The scorings of the Montreal experts bring out several points :

1. The variation in scores of the five judges is considerable, amounting in one case to as much as eleven points on the flavor.

2. The average scorings of all the July lots containing preservatives was quite uniform. The extreme variations were 38.1 to 40.1 out of 45. Boracic acid gave the lowest average score and preservative No. 6 slightly the highest.

3. The lots containing salt at the rate of 3-4 oz. per pound of butter averaged 35.4 out of a possible 45 for flavor. These lots were entirely free from mould, while all the other lots made in July were badly moulded.

EXPERIMENT OF SEPTEMBER 14, 1904.

One of our regular churnings of sweet pasteurized cream on Sept. 14th, was divided into eight lots of 28 pounds in each box. To the butter in each was added one-quarter of one per cent. of preservative and the boxes were numbered as in the other experiments, and placed in cold-storage at about 40 degrees F.

The scorings on October 4th, 1904, and March 4th, 1905, were as follows :

Preservative.	Score for Flavor. Max. 45.		
	Oct. 4th, 1904.	Mar. 4th, 1905.	Average.
1. Borax	41	34	37.0
2. Boracic Acid	42	32	37.0
3. Commercial Preservative	42	33	37.5
4. " "	42	36	39.0
5. " "	42	35	38.5
6. " "	42	34	38.0
8. " "	42	35	38.5
9. Sodium Fluoride	38	37	37.5

In this experiment, the lot made by using sodium fluoride as a preservative was given the lowest score on October 4th, 1904, and the highest score on March 4th, 1905. While sodium fluoride appears to be a very good preservative, owing to its apparent harmful effect on the human system it is not to be recommended. Another point brought out very markedly in this experiment was the fact that all the lots in which borax, boracic acid, and commercial preservatives were used had moulded very badly in the storage, while the box in which sodium fluoride was used, contained no mould whatever.

A SPECIAL TEST.

On December 6th, 1904, nine pound prints and one 28 lb. box of butter were taken from one of our regular churnings. The objects of this experiment were:

1. To test the effects of one-half and one-quarter per cent. of preservatives and also salt on prints of butter kept in a warm room for about five weeks.

2. To compare the preservatives which we had been using in our previous summer work with a special, imported, commercial preservative which we shall designate as No. 10. We also wished to test this preservative with reference to mould.

The prints of butter wrapped in parchment paper were placed directly after making in a room where the temperature ranged from 60 to 70 degrees and remained there until January 13th, 1905, (38 days) when they were scored and afterwards moved to an ice cold-storage, where they remained at a temperature of 30 to 32 degrees F. until March 4th. They were again scored by five of the instructors in the Dairy School. The box was put in the ice storage as soon as made and was not scored until March 4th, 1905. At this date neither the box nor any of the prints had developed any mould. It is probable that the conditions of temperature and moisture in winter were unfavorable for its growth.

The scorings of the various lots as given by one of the writers on January 13th and by five instructors of the Dairy School on March 4th, were as follows:

Preservatives.	Flavor 45. Score, Jan. 13th, 1905.	Flavor 45. Score, Mar. 4th, 1905.	Flavor 45. Score, Average.
1. Borax $\frac{1}{2}\%$ (print)	35	36	35.5
1. " $\frac{1}{4}\%$ "	30	25	27.5
4. Com. P. $\frac{1}{2}\%$ "	30	27	28.5
4. " $\frac{1}{4}\%$ "	30	25	27.5
6. " $\frac{1}{2}\%$ "	35	35	35.0
6. " $\frac{1}{4}\%$ "	37	30	33.5
7. Salt $\frac{3}{4}$ oz. "	30	23	26.5
10. Com. P. $\frac{1}{2}\%$ "	32	35	33.5
10. " $\frac{1}{4}\%$ "	30	27	28.5
10. " $\frac{1}{2}\%$ (box) .....	.....	40	.....

In this, what may be considered a severe test, the lots preserved with borax appear to have given as good or slightly better results than any of the commercial preparations. It would also seem that one-quarter of one-per cent of preservative did not hold the flavor of the butter so well as did the half per cent. and that salt was not nearly so good as the boron preparations. In this one trial the No. 10 commercial preservative did not give any better results than did those tested during the summer.

The box of butter put into cold-storage held its flavor much better than did the prints which were exposed to a high temperature for 38 days.

PRESERVATIVES FOR CREAM.

It has been recommended that patrons of cream-gathering creameries be supplied with a preservative to place in the cream to prevent its souring before delivery. A few trials were made of a special cream preservative, between July 16th and 25th. For these trials a large test tube was used having a cotton plug in the open end. The samples were kept at a temperature of 60 to 70 degrees F. in an ordinary room. The amount of preservative was as nearly as possible the proportion as recommended by the manufacturers. The following are some of the results:

July 18, 11.30 a.m. Pasteurized and cooled skim-milk placed in a added. Cream thick and sour 11 a.m., July 18th.

July 18, 11.30 a.m. Pasteurized and cooled skim-milk placed in a test tube and preservative added. Sample sour and thick 10 a.m. on the 20th.

July 20, 10 a.m. Skim-milk from separator which had not been pasteurized or cooled was added to test tube. Milk was separated at a temperature of 90 degrees F. Extra amount of preservative added. 9 a.m. on the 21st, sample sweet but had a bad flavor. On the 23rd at 3 p.m. sample slightly sour. Flavor not so bad as on the 21st. On July 25th, flavor improved and acid developed slightly more but not thick at 10.30 a.m. on the 25th. The sample was thick on the morning of the 26th.

While these trials are not conclusive, they point to the fact that a considerable amount of the preservative would have to be used to keep cream sweet in hot weather, and also indicate that though we may keep a sample sweet by this method, we do not prevent the development of bad flavors which may be more objectionable than simple souring.

GENERAL CONCLUSIONS.

1. Powdered borax, in these experiments, has given as good results as the commercial preservatives, although manufacturers of the latter claim that borax is unsuitable as a preservative, as the following quotation from a letter received from one of the firms will show, "We know, from a number of experiments conducted under our personal supervision, provided well-made butter of a delicate flavor were in question the———treated butter must yield a finer flavor than borax-treater butter. Borax, as a matter of fact, is a most unsuitable preservative for butter as any practical butter manufacturer must know, as borax is alkaline in its action and would tend to saponify butter."

We do not find the foregoing results in our experiments, although further work is needed to settle the matter definitely. The borax costs about one-half as much per pound as the commercial preservatives.

2. One-quarter of one per cent. of powdered borax or of the commercial preservatives appears to be sufficient to hold the butter flavor under ordinary conditions, and is not nearly so liable to give the "preservative taste" to the butter. Butter which is likely to be held for over three months or which may be exposed to high temperatures may have one-half of one per cent. added.

3. The results indicated better keeping quality in the sweet cream butter than in those lots made from ripened cream.

4. There was not much difference in the keeping quality of the butters treated with the different preservatives, boracic acid giving the poorest average and commercial preservative No. 6 rather the highest.

5. All the boxes and prints of butter made during the summer to which the borax, boracic acid, or commercial preservatives had been added developed mould very badly, while the samples which were salted were free from mould.

6. Under the severe test of December 6th, none of the preservatives may be considered as having given satisfactory results, although the flavor was very much better in those lots as compared with the lots treated with salt alone.

7. At the present time we are not prepared to recommend the use of milk or cream preservatives.

8. For the home trade, with proper means for pasteurizing the cream and suitable cold-storage facilities, we do not consider that preservatives, other than salt, are needed to keep butter for a reasonable length of time.

9. For the export trade which allows one-half of one per cent. boracic acid in butter it would seem as if this amount might be used to advantage in some cases, but with suitable cold-storage and especially where pasteurization is followed, less than this amount would preserve the butter and be less liable to injure the consumer.

10. Salicylic acid, sodium fluoride, and formalin may not be recommended as butter preservatives. The first one is more or less harmful, and gives an objectionable flavor to butter, while the latter two are considered quite harmful to the human system.

Ontario Department of Agriculture.

WOMEN'S INSTITUTES.

Uses of Fruits, Vegetables and Honey.

USE OF FRUITS.

FOOD VALUE. While fruits may be said to have a low nutritive value, they are not as a rule estimated at their real value as food. They supply a variety of flavors, mineral substances, some carbo-hydrate and a necessary waste or bulky material for aiding in intestinal movement. The flavors of fruits, while they elude chemical analysis, are their most valuable possessions as stimulents to the appetite, and aids to digestion. The mineral substances consist mainly of potash united with various vegetable acids. These acids are converted in the body into the corresponding carbonates and so help to render the blood more alkaline. In some diseases, such as scurvy, this property is turned to good account.

All fruits contain pectin or vegetable jelly and cellulose. Pectin is the main constituent of fruit jelly.

WHEN TO EAT. Fruit is best eaten at breakfast or between meals. A good apple first thing in the morning and the last thing at night is a standard specific for indigestion. After a heavy dinner it is not so valuable in the diet.

EXPOSURE OF FRUIT IN STORES. Since the softer fruits decompose so readily they should be eaten as fresh as possible. When fruits are exposed to the air and the dust of the streets, as is so often the case, they are exceedingly apt to decompose and suffer fermentative changes which are very dangerous, and a fruitful source of digestive derangements.

As may be inferred it is of the first importance that fruits be ripe and in good condition. They must also be delicately handled, as their great value may be readily lost in careless handling. Luscious fruits are so particularly liable to putrefactive changes, that we must have recourse to some of the various methods of preserving them.

SELECTION AND PREPARATION. The selection of fruit is the first step in obtaining successful results. The flavor of fruit is not developed until it is fully ripe, but the fermentation stage follows so closely upon

the perfectly ripe stage, that it is almost safer to use it a little under-ripe than over-ripe. For the making of jelly, the fruit should always be under-ripe. Fruits should, if possible, be freshly picked for preserving; no imperfect fruit should be used.

In the preparation for preserving, system will do much to lighten the work. Begin by having a clean kitchen to work in. Have plenty of hot water in readiness. Have at hand all necessary utensils, towels, spices and sugar. Decide upon the amount of fruit you will cook at one time, then have a bowl that will just hold this quantity. As the fruit is prepared, drop it into the measuring bowl; when the measure is full, the fruit may be put directly into the preserving kettle. This saves handling and at the same time secures exactness.

HINTS FOR PRESERVING TIME. If fruit is very juicy, avoid adding water to it when canning. The less water that has to be used, the finer the flavor of the preserve and the more beautiful its color. Never touch cooking fruit with a spoon or fork which is of any material except silver, wood or granite. A tin spoon may ruin the color and flavor of a whole kettle of fruit. Try a little of your sugar to make a syrup before commencing the canning process. If a bluish-gray scum gathers on top after the boiling, send the sugar back to the grocery-man with an order for a better quality. When the fruit has been put in the jars, it is a good idea to turn them upside down and allow them to stand that way for a few minutes to make sure they are perfectly air-tight, because if they are not, all the previous precautions are in vain.

PRINCIPLES OF CANNING AND PRESERVING.*. In the preservations of fruits by canning, preserving, etc., the essentials in the processes are sterilization of the fruit, of all utensils used, and the scalding of the fruit to prevent all germs entering, so keeping it sterile. To accomplish this, the spoons, strainers and glass jars should be put on the fire in cold water and allowed to boil for some minutes. The jars must be taken one at a time from the boiling water at the moment they are to be filled with the boiling fruit. The work should be done in a well swept and dusted room, and the clothing of the workers and the towels used should be clean. The fruit used should be sound and clean. If over-ripe it is difficult to make it sterile even with considerable boiling.

METHODS OF PRESERVING. There are many methods of preserving fruit all involving the same principle. The conditions under which the housekeeper must do her work may make one method more convenient than another. There are four common methods: Cooking the fruit in jars in the oven; cooking the fruit in jars in boiling water, cooking fruit in a syrup; and stewing fruit.

The first two methods are very useful for juicy fruits, such as berries and cherries that require no water. Prepare the jars and fruit as for ordinary canning. Fill the jars with the raw fruit, using a cup of sugar

NOTE. The word "preserved" is used in a general sense—"to keep."

to a quart jar of fruit, sprinkle the sugar through the fruit; seal the jars and place them either in the oven or in hot water on the top of the stove—the wash boiler is usually used when the fruit is cooked in the last named way. Cook fifteen minutes or till the fruit is soft through. The jars will have to be filled one from the other and resealed.

The other fruits may be done by this method:—Make a syrup, prepare the fruit the same as for cooking in the preserving kettle. Fill the hot jars with it and pour in enough syrup to fill the jar solidly. Cook as above. It is thought by many that fruit cooked in this way retains its shape, color and flavor better than when cooked in the preserving kettle.

The syrups used for preserving vary according to the kind of fruit you wish to preserve, and the richness desired. The following list is one given by Miss Parloa;—

For preserving use $\frac{3}{4}$ lb sugar to 1 lb fruit.

For making jam use 1 lb sugar to 1 lb fruit.

For canning use $\frac{1}{2}$ lb sugar to 1 lb fruit.

For jelly use 1 lb sugar to 1 pt. fruit.

The process of making syrup is very simple. Put the sugar and water into a sauce-pan and stir on the stove until all the sugar is dissolved. Heat slowly to the boiling point and boil gently without stirring. The length of time that the syrup should boil depends on the richness desired. Put the prepared fruit into the syrup and simmer until tender.

In stewing fruit, put the prepared fruit into a sauce pan with enough water to keep it from burning. Cover closely and stew until tender, stirring often, add the sugar and let it boil a moment longer.

JELLY MAKING.

Before the principles of sterilization were understood, fruit was preserved by cooking it with its own weight of sugar. Only jellies are done in this way now. The juice of almost any fruit can be used for jelly making; those that contain a considerable amount of pectin are the best. Pectin is most abundant in the juices of the hard parts of the fruit, the core and the skin; therefore, these parts should always be used in making jelly.

Apples, quinces, crabapples, currants and grapes make the best jellies. Blackberries, raspberries, and peaches are also used.

An acid fruit is the most suitable for jelly making, although in some of the acid fruits, the strawberry, for example, the quantity of the jelly making pectin is so small that it is difficult to make jelly with this fruit. If, however, some currant juice be added to the strawberry juice, a pleasant jelly will be the result. Of course, the flavor of the strawberry will be modified. The method of making jelly is the same for all fruits. See that the fruit is clean, free from all leaves and stems, but do not

remove the skin. Put the fruit in the preserving kettle with just enough water to prevent burning, heat slowly and stir frequently. Cook the fruit until well broken, put a wire strainer over a large bowl, over this spread a double square of cheese cloth. Turn the crushed fruit and into the cheese-cloth, and let it drain as long as it drips, but do not use pressure. Measure the juice and put it in a clean preserving kettle. For every pint of juice, add a pint of granulated sugar, stir until the sugar is dissolved, then place over the fire, watch closely, and when it boils up draw it back and skim; put over the fire again, and boil and skim once more; boil and skim a third time, then pour into hot glasses taken from the pan of water on the stove. If the juice be rich in pectin—not watery—even as little as half the quantity of sugar will be sufficient. As soon as the jelly is set, i.e., thickens slightly when dropped on a cold plate, cover by the following method:—Have discs of thick white paper the size of the top of the glass, dip a disc of paper in the spirits and put it on the jelly. If the glasses have covers put them on, if not, cut discs of paper half an inch in diameter larger than the top of the glass. Beat together the white of an egg and a teaspoonful of cold water. Wet the paper covers with this mixture and put over the glass, pressing down the sides well to make them to stick to the glass. Paraffin is sometimes used to cover jelly to protect it from moulds. About one-eighth of an inch in thickness is sufficient.

A wooden spoon is best to use in preserving. It is light; does not melt as metal ones often times do; does not impart flavors; the handle never gets hot; and last, but perhaps not least, it makes no jarring noise to affect nerves which may be otherwise strained.

APPLE DISHES.

APPLE FLOAT. Make the old fashioned apple sauce by stewing the apples until soft, sweeten and beat, then add the beaten whites of eggs, and pile on nice white dish. This can be served with a soft custard made from the yokes of the eggs.

APPLE SNOW. Pare and core six good sized apples and steam them in two tablespoonsful water with a little lemon peel until quite soft. Add one-fourth pound finely sifted sugar, let cool, and whip in whites of two fresh eggs. Beat well, without stopping, to a stiff snow, and serve heaped up in custard glasses with a star of red currant jelly on top.

APPLE ICING. White of 1 egg; $\frac{3}{4}$ cup granulated sugar; 1 apple (grated). Beat all together for half an hour; flavor with almond.

BAKED APPLES. To bake in their skins, wash and wipe, and place in earthenware or graniteware baking dishes, as tin or iron injures the flavor of the fruit. They should be baked until they form a frothy, pulpy mass, and if there is any danger of the juice burning on the baking dish, add a little water. Eaten with cream they form a delicious dessert.

Or they can be peeled and cored and the centres filled with spiced sugar and a small piece of butter. Pour a little water in the baking pan, and a rich juice is formed, which can be used for basting them.

BAKED APPLE SAUCE. Pare, quarter and core large apples and pack in an earthen jar with brown sugar, cover closely and bake slowly in a moderate oven until the contents have been shrunk to about half their original bulk and are rich, red and luscious.

APPLE COMPOTE. Core and peel as many apples as are wanted and cook slowly in a syrup made by boiling one cup of sugar to one cup of water. When done lift to a dish and fill the spaces where the cores were with apple jelly and sprinkle with granulated sugar. Pour the syrup around them.

Nice red apples can be quartered and cored and the skins left on them and cooked slowly in the same way, turning them in order that both sides may be cooked alike. They make a nice dish for breakfast or tea.

APPLE MERINGUE. Peel, core and slice ten or twelve good sized apples. Cook them with three ounces of sugar, 2 ounces of butter, and the grated rind of a lemon. Cook as dry as possible, then beat them till smooth and form in a loaf shape. Cover with a meringue made of the whites of two eggs beaten till stiff, with two tablespoons of sugar, added to the egg just before using. Bake in a moderate oven till a nice golden brown. Serve with a boiled custard sauce.

APPLE FARCI WITH WHIPPED CREAM. Core but do not peel six nice large apples. Steam until tender. Boil half a cup of sugar with one cup of water for five minutes. Add half a cup each of cherries and shredded pine apple. Place the steamed apples upon slices of stale cake, putting the boiled mixture into the centres. Pour whipped cream over the apples; sprinkle with chopped nuts.

NEW ENGLAND APPLE SAUCE. Pare, core and quarter nice tart apples. Put them in an earthen dish, sweeten and spice to taste. Cover with water; lay a cover on the dish and bake the apples till tender.

FRIED APPLES. Wash and wipe large tart apples. Slice in thick rounds. Have a skillet with hot butter in it; put the apples in; sweeten; cover and cook slowly until brown. Watch carefully or they will burn.

APPLE CUSTARD PIE. 2 well-beaten eggs; 1 cup grated apple; 1 pint sweet milk; 2 large spoons sugar salt and flavor.

PLAIN MARLBORO PIE. Into 2 cups of sifted apple sauce, stir while hot 2 tablespoons of butter. Beat the yolks of 2 eggs; add 1 cup sugar; $\frac{1}{2}$ of the grated rind, and all the juice of 1 lemon. Mix this with the apple. Cover plate with a rich crust; turn in the mixture and bake about half an hour in a moderate oven. Cover with meringue or whipped cream, or put a top crust on.

STEAMED APPLE PUDDING. Two cups of flour; four teaspoons baking powder; one half teaspoon of salt; two tablespoons butter; three quarters of a cup of milk; four apples cut in eighths.

Mix and sift dry ingredients; work in butter with tips of fingers, add milk gradually, mixing with knife; toss on floured board, roll out, place apples on middle of dough and sprinkle with sugar, bring dough around apples and carefully lift into buttered mould, cover closely and steam one hour and twenty minutes.

APPLE TAPIOCA. Three quarters of a cup of tapioca; seven sour apples; one half teaspoonful of salt; cold water; one half cup of sugar; two and one half cups of boiling water.

Soak tapioca one hour in cold water to cover, add boiling water and salt; cook in double boiler until transparent, pare and slice apples, place in a buttered pudding dish, sprinkle sugar over apples, and pour over tapioca, and bake in moderate oven until apples are soft.

APPLE BATTER PUDDING. One cup flour; one egg; one half cup milk; one half cup of sugar; two tablespoons butter; one teaspoon baking powder; one quarter teaspoon vanilla; six sour apples.

Cream butter and sugar, sift flour and baking powder together, beat egg and milk together, add the milk and egg alternately with the flour to the creamed butter and sugar, add flavoring. Pare and slice apples, place in a buttered baking dish and pour over batter. Bake fifteen to twenty minutes.

APPLE JAM. Core and pare the apples; chop them well, allow equal quantity in weight of apples and sugar; make a syrup of sugar by adding a little water, boiling and skimming well, then throw in a little grated lemon peel and a little white ginger. Boil until the fruit looks clear.

PICKLED APPLES. Apple pickles are delicious. Pare and halve the apples, removing the cores carefully, to keep them in good shape, steam till soft. Put spiced vinegar over them.

PRESERVED APPLES. Pare and core ripe sour apples. Strew the bottoms of two Mason jars with granulated sugar an eighth of an inch thick; cover with a layer of thinly-sliced, very ripe apples, sprinkle freely with sugar, and alternate apples and sugar until the cans are full: Set the jars up to the neck placing underneath a plate or board in water as hot as can be borne without danger of cracking the jars, and increase the heat until the sugar is dissolved half an hour. Take from the fire, fill one can from the other and seal closely as in canning.

OLD FASHIONED BOSTON APPLE PUDDING. Peel a dozen and a half good tart apples. Core, cut small, and put in a stew pan. Add a tablespoonful of water for each apple; $\frac{1}{2}$ teaspoon cinnamon; 2 cloves, and the grated rind of half a lemon. Stew over a slow fire until quite soft. Sweeten to taste and rub through a coarse sieve. Add the yolks of 4

eggs and the white of 1; $\frac{1}{4}$ pound of good butter; $\frac{1}{2}$ a nutmeg, and the rest of the lemon rind grated, also the juice of the lemon. Beat all well together. Line the inside of a deep pie dish with puff paste, put in the pudding and bake forty minutes.

PICKLING.

A recipe which can be adapted for pickling all sorts of fall fruits calls for four pounds of light brown sugar to seven pounds of fruit, one pint vinegar and one ounce whole cinnamon, half an ounce of cloves and all-spice tied in a tiny muslin bag. Wash the fruit thoroughly, dry, and over same put the sugar, allowing it to stand twenty-four hours, at the end of this time the sugar will be reduced to a syrup. Drain it off the fruit; add to the vinegar and spices and let it boil for half an hour; put in the fruit and simmer gently till you can pierce the fruit with a straw; lift the fruit out carefully into a jar and allow the syrup to cook until quite thick, then pour over the fruit and put away covered tightly.

PLUMS.

Plums are especially well adapted for making the commoner varieties of jellies and jams. The larger and more expensive varieties may be canned or preserved according to general directions given above.

COLD WATER PROCESS FOR CANNING. Carefully select fruit, wash, then fill in thoroughly sterilized jars and pack firmly. Fill jars with cold water, screw lids on loosely, stand jars in boiler well protected at the bottom either by a board or several thicknesses of cloth, fill the boiler with water to within one-half inch of top of jars. Heat gently to boiling point, boil until tender. Allow jars to cool slightly, then remove and fill jars with boiling water and seal tight. When required for use add sugar several hours before serving.

The chief virtue of this method is that the natural fresh flavor of the fruit is retained.

PICKLED PLUMS. 4 quarts plums; 4 pounds sugar; 1 pint vinegar; $\frac{1}{2}$ tablespoon cloves; 1 tablespoon cinnamon. Cook for half an hour. Serve with meats.

PEARS.

The general directions given for canning and preserving are applicable for pears. Pears should not be long exposed after the skins have been removed, as the air has the effect of discoloring.

CANNED PEARS. Prepare as in general directions and either leave the pears whole or cut in halves or quarters. It is always well to use some flavoring such as ginger root or lemon rind.

SWEET PICKLED PEARS. Half a peck of pears, one pint of vinegar, two pounds of brown sugar, one ounce stick cinnamon, cloves. Boil sugar, vinegar and cinnamon twenty minutes. If small pears are used,

pickled whole; if large, quarter. Stick each pear with four cloves. Put into syrup and cook until soft.

Pears have less cellulose and less acid than apples, and are best eaten raw.

BAKED PEARS. Peel some large, sound pears, arrange them in a porcelain baking dish, with the stalk end upward. Pour a little water over them, and enough good molasses to sweeten thoroughly. Bake in a slow oven for several hours. They gain in flavor if basted with the molasses occasionally.

PEACHES.

In preparing varieties for canning, preserving or pickling, first put in boiling water, allowing them to stand just long enough to loosen the skin. Remove skins and cook fruit at once in order to avoid discoloration. Peaches may be pickled in the same way as pears.

PEACH TAPIOCA. 1 cup tapioca, soak one hour in cold water and drain. Add enough water to the syrup poured from a can of peaches to make in all three cups; add the soaked tapioca, and $\frac{1}{4}$ cup sugar and a little salt to this liquid. Cook till thoroughly clear, line a mould with the peaches, dust with sugar, and fill with the tapioca; serve with whipped cream.

QUINCES.

PRESERVED QUINCES. Pare, core and quarter quinces, then weigh them. Put parings, cores and seeds into preserving kettle, cover with water, and boil slowly twenty minutes, then strain them, put the water back and put in quinces a few at a time and simmer gently till tender; lay them on a dish. When all are done, add sugar and a little warm water. Let them boil for a few minutes until clear then put in all the quinces and boil without stirring until they become a clear garnet. Have ready two lemons sliced thin and seeds taken out. Put in a few minutes before taking off the fire.

QUINCE JELLY. Cut quinces into quarters, without paring or coring, cover with water and cook until soft; strain, and proceed according to general rules for making jelly.

GRAPES.

CANNED GRAPES. Pulp the grapes; boil the pulp five minutes; strain to take out seeds; put skins and pulp together; put pound for pound of sugar; boil half an hour, then add a little nice apple sauce that has been strained and cook for ten minutes.

GRAPE CATSUP. Six quarts of grapes off the stems; pulp, then boil the pulp until seeds come out; strain through colander. Take a ten pound basket of apples and make into sauce. Use one quart of water; one quart of vinegar; three pounds of sugar; all kinds of spices. Boil.

SPICED GRAPES. Pulp one peck of grapes; boil for five minutes; strain to take out seeds; put the skins and pulp together and add three pounds of sugar; one pint of vinegar; one teaspoon cloves; one teaspoon cinnamon; one teaspoon allspice. Cook until thick.

GRAPE RELISH. (To be used with fowl.) Take ten pounds of under ripe grapes, boil for five minutes, strain, add one pound of sugar to one pound of fruit juice, also one teaspoon each of cinnamon, cloves and allspice. Boil five minutes; strain into moulds.

UNFERMENTED GRAPE JUICE. Stem and wash grapes, place in preserving kettle, add water to about one inch from top of grapes (the same as in making jelly), boil until all are broken, strain through a jelly bag, add one quart of sugar to two quarts juice and boil ten minutes; bottle and seal. Some persons prefer to add the sugar at the time of using the wine.

STRAWBERRIES.

The popular estimation of the strawberry is reflected in the saying, "Doubtless God could have made a better berry than the strawberry, but he never did."

In canning strawberries the chief difficulty lies in preserving the form of the fruit. With strawberries, and all watery fruits, it is well to prepare the fruit, and sprinkle over it the sugar to be used; allow it to stand over night; pour the juice into a preserving kettle; bring to a boil, skim and then add the fruit, cooking only for a few minutes after it comes to the boil. Bottle carefully and keep in a cool, dry place. Canned in this way the fruit retains both form and color.

CURRENTS.

Red currants are most valued for jelly making. Spiced currants are also a great relish, and a desirable tart fruit throughout the year when preserved in water (cold water process.)

BLACK CURRANT PRESERVE. Cook until tender in water or a very light syrup sufficient to nicely cover the fruit. Strain through a colander. Add sugar to liquid equal in volume to both liquid and currants, taking into account the sugar already added; if currants were cooked in syrup. When liquid and sugar are jellied add currants and bring to boiling points, then fill into sealer.

ROLLY-POLLY PUDDING. Make a rice, short, biscuit crust, with 2 cups of flour, 3 teaspoons baking powder, 2 tablespoons lard, 2 tablespoons butter, salt, add milk enough to make a light dough. Roll out to half an inch in thickness, spread with black currant jam, roll up in floured cloth and boil for one hour.

RHUBARB.

Cut the rhubarb when it is young and tender. Wash it thoroughly; cut into pieces about half an inch in length. Pack in sterilized jars.

Fill the jars to overflowing with cold water, and let them stand ten minutes. Drain off the water and fill again to overflowing with fresh cold water. Seal with sterilized covers. When required for use treat the same as fresh rhubarb. Green gooseberries may be preserved in the same way.

RHUBARB AND ORANGE COMPOTE.

1 pint bottle rhubarb, 3 oranges, 1 cup sugar. Peel the oranges, removing as much as possible of the white pith; divide into sections; put all the ingredients together into a preserving kettle and simmer gently for about an hour.

RHUBARB.

1 pint of "cold water" rhubarb; put into double boiler with $\frac{1}{2}$ a cup of sugar; small grating of lemon rind; small piece of ginger. When quite cooked set aside to cool; remove ginger. Soak $\frac{1}{2}$ ounce of gelatine in $\frac{1}{4}$ cup of cold water; add, when softened, $\frac{1}{4}$ cup hot water to dissolve; add to rhubarb with 1 tablespoonful of lemon juice. Pour into a mould when nicely set. Serve with whipped cream.

PRUNES.

Pruns can be cooked up so that they will be rich and deliciously flavored.

When buying prunes see that they are large and solid and have the surface unbroken. Take one in your hand, pull and flatten it out. If it leaves the skin unbroken and shiny you may feel sure that you have the proper article. After washing them let them stand in cold water over night. In cooking place them in the saucepan with plenty of cold water to cover. When they come to a boil, set the saucepan where it will keep on an even but steady slow boil. An hour and a half is none too long for prunes to cook. By that time the syrup is reduced to a thick consistency, which, when cold, will almost jelly. As soon as the prunes are put on the fire the lemon goes in with it. Allow one lemon to three quarters of a pound of prunes. Shave off the yellow rind as thin and small as possible, then peel off the thick, white portion, discarding the inner lining and bitter part of the skin. Slice the lemon and add it all to the prunes. When they have boiled about half an hour add the sugar. As you stir and watch them occasionally, taste and see if they have a lemony flavor. Sometimes the right amount of sugar has not been added to draw out that flavor. Allow about a cup of sugar. When done the syrup should just cover the prunes. By following the given recipe carefully it is as possible to have your stewed prunes rich and delicious as a more choice preserve. In the following recipes the prunes are first stewed in this way before being made into the jellies, and so on. By pitting and mincing the prunes to a jam they make a rich pie filling. Have a meringue top or pie crust.

PRUNE PUDDING. Stew half a pound of prunes till quite soft. Press through a coarse sieve, sweeten to taste, add the well-beaten whites of three eggs, 1 tablespoon of flour, 1 teaspoonful of butter. Pour into a pudding dish and bake in a moderate oven for twenty minutes.

Table showing uses for which the commoner varieties of fruit are best suited.

APPLES.

Variety.	Season for Use.	Sauce.	Jelly.	Baking.	Pies, etc.	Dessert.
Alexander	Sept.—Oct.	a	.....	b	a	b
Astrachan	August	al	al	.....	a	a
Baldwin	Jan.—Mar.	b	.....	b	b	b
Bellefleur	Jan.—Mar.	a	.....	a	a	a
Ben Davis	Mar.—May	b	.....	.....	b	.....
Blenheim	Nov.—Feb.	a to b	.....	b	a	a
Duchess	Aug.—Sept.	al	.....	a	a	b
Early Harvest	July.—Aug.	a	.....	.....	a	al
Fameuse	Sept.—Dec.	.....	a	a	.....	al
Fall Pippin	Oct.—Dec.	al	.....	al	al	a
Gravenstein	Aug.—Sept.	al	.....	al	al	al
Greening	Jan.—Mar.	al	.....	al	al	a
King	Dec.—Feb.	al	.....	al	al	al
McIntosh	Nov.—Jan.	al	a	al	al	al
Ontario	Jan.—Mar.	al	.....	a	a	.....
Russett	Jan.—May	b	.....	.....	b	a
Ribston Pippin	Oct.—Dec.	a	.....	b	a	a
Spy	Jan.—Mar.	al	.....	a	al	al
Seek-No-Further	Dec.—Feb.	a	.....	b	.....	a
Tolman	Dec.—April	.....	.....	al	.....	a
Wealthy	Sept.—Nov.	a	b	b	b	a
Wagener	Nov.—Jan.	a	.....	.....	a	a

al—Excellent.

a—Good.

b—Fair.

PEARS.

VARIETY.	Season for Use.	Canning.	Sauce.	Pickles.	Pies.	Dessert.
Giffard	Early Summer	a	a	.....	.....	al
Bartlett	Late Summer.	al	a	.....	a	al
Flemish Beauty	"	al	a	.....	a	al
Bosc	Autumn	.....	.....	.....	.....	al
Duchess	September	al	.....	.....	a	al
Louise	Sept.—Oct.	.....	.....	.....	.....	al
Lawrence	Nov.—Jan.	.....	.....	.....	.....	al
Anjou	Early Winter.	a	b	b	.....	al
Kieffer	Nov.—Dec.	al	a	a	a	.....

PEACHES.

VARIETY.	Season for Use.	Canning.	Pickles.	Pies-	Dessert.
Alexander.....	July 25				b
Yellow St. John.....	Aug. 15	al	al	al	al
Early Crawford.....	Aug. 24	al	al	al	al
Late Crawford.....	Sept. 24	al	al	al	a?
Champion.....	Sept. 3	al	al	al	al
Elberta.....	Sept. 12	al	b	a	b
Longhurst.....	Sept. 12	al	al	al	b
Smock.....	Oct. 1-15th.	al	al	al	b

PLUMS.

Variety.	Season of Use.	Canning.	Sauce.	Pies.	Dessert.	Drying.
Red June.....	Aug. 1-15.....	a	a	a	a l	.....
Abundance.....	Aug. 10-20.....	a	a	a	a l	.....
Bradshaw.....	Aug. 15-30.....	a	a	a	a l	.....
Coe.....	Early Sept.....	a	a	.....	a	.....
Green Gage.....	Aug. 15-30.....	a l	a l	a l	a	.....
German Cream.....	Sept. and Oct.	b	b	b	b	a l
Purple Egg.....	Sept. 15-30.....	a	a	b	b	b
Quackenbos.....	Sept. 15-30.....	a	a	b	b	.....
Washington.....	End of Aug.	a	a	a	a l	b
Reine Claude.....	Sept.....	a l	a l	a l	a	.....
		Specially good for pickles.				
Satsuma.....	End of Aug.	Specially good for jelly.				

The following are some of the most desirable varieties of Grapes: Brighton, Campbell, Concord, Delaware, Lindley, Moyer, Moore, Niagara, Salem, Vergennes, Worden.

VEGETABLES.

Green vegetables are less nutritious than roots, and are valued chiefly for their dietetic value and for their flavor. They are largely composed of water and cellulose, which makes them useful as laxatives. They contain as a rule about 90 per cent. of water, and only $1\frac{1}{2}$ to 3 per cent. of muscle-building materials. But their value in the diet cannot be

over estimated. Taken individually we find that most of them have a medicinal value, which if fully appreciated by the public would do much to decrease the alarming consumption of patent medicines which at present prevails amongst our people.

ASPARAGUS is not a delicacy of recent date, but was highly valued by the Romans as long ago as 425 B.C. The green asparagus is considered the best variety, and may be grown to perfection among the vines in our southern counties. It is only slightly nutritive, but contains a crystalline nitrogenous substance called asparagin, which produces marked physiological effects.

CABBAGE contains sulphur, and is therefore flatulent in effect. Boiling dissipates a good deal of the sulphur compounds and softens the cellulose, but cabbage is never so digestible as when young, and eaten raw, with vinegar, as with salads.

CAULIFLOWER is an inflorescence of a species of cabbage. It is the most delicate and digestible of all the cabbage products.

KALE, another cabbage plant, has rather an acrid flavor, but is delicate and easily digested.

BRUSSELS SPROUTS are little clusters of leaves resembling cabbages formed in the axils of the main leaves, and are very good, being delicate in flavor and easily digested.

CELERY, either roots or blanched stems, are eaten raw, alone or in salad, or used to flavor soups, or boiled with cream sauce. The blanched stalks contain an aromatic oil, sugar, mucilage, starch, and also manose sugar, which is also found in honey, and is strong stimulants to the excretory organs. The daily use of celery as a salad is said to remove nervousness and palpitation of the heart. Onions have also the same effect and may be used when celery is out of season. It is also used in rheumatic cases. This painful ailment will yield to the continual use of celery, prepared in the following manner.

Cut the celery into pieces and boil in water until soft. This "stock" of water should be drunk by the patient. Put whole milk and a little flour and a grating of nutmeg into a sauce pan with the boiled celery; bring to the boil, and serve hot with pieces of toast.

LETTUCE is cooling and easily digested. It is a blood purifier and gently laxative in its action. The milky juice is somewhat narcotic and is sometimes used as a sedative.

ONIONS. All varieties are nutritious, and valuable as blood purifiers; also stimulate digestion, and, like celery, are useful for nervousness. "Personal equation" figures largely in the use of onions, as some persons cannot tolerate them at all, while others eat them with apparent relish.

GOURDS. In this group of vegetables we have pumpkins, vegetable marrow, squash and egg plant,—all of them being easily digested, but

of low nutrient value. They have a good dietetic value, as the quantity of water they contain is so large.

CUCUMBERS. Are chiefly of value for the water they contain.

MELONS are also valuable for the amount of water they contain, being more of a drink than a food.

TOMATO, itself the "prince of salads," is never better than when eaten fresh and raw. We have no other vegetable that is capable of being cooked and served in so many ways. The tomato owes its pleasant sour taste to oxalic acid, and on that account, like rhubarb, is generally forbidden to those with gouty tendencies. Since oxalic acid forms insoluble salts with lime and magnesia, excessive use of rhubarb or tomatoes tends to thin the blood, and produce outbreaks on the skin.

PICKLES.

CHILI SAUCE. 18 large, ripe tomatoes, 6 onions, 6 small red peppers, $\frac{3}{4}$ cup sugar, 2 cups vinegar, salt to taste.

Peel the onions and tomatoes, remove the seeds and core from the peppers. Chop all very fine, add the sugar and salt, boil slowly until the sauce becomes quite thick; then put away in well sterilized bottles.

SPICED TOMATOES (Suitable for Game.)

Peel and slice the tomatoes and put them in the preserving kettle with sugar, (half as much sugar as fruit, by weight.) A quart of vinegar and 1 ounce each of ground mace, cloves and cinnamon. Mix and cook slowly for three hours. Put in glass jars and seal.

ROOTS AND TUBERS.

POTATOES. The value of the potato as food lies in its starch. It is very poor in nitrogenous material, and cannot be used alone in support life. Its deficiencies material, and cannot be used alone to support life. Its deficiencies in this respect are supplied by the more concentrated foods, rich in proteids and fats, with which it is usually served. Potato juice is acid containing many substances that tend to purify the blood, but the water in which potatoes have been boiled is not wholesome. That in which new potatoes have been boiled is especially so. Severe diarrhoea has been caused by the indiscriminate use of potatoes containing unformed starch and immature cellulose. Potatoes may be stored in pits, or in a cool, dark, well-ventilated cellar; light and frost both being injurious to potatoes. The addition of a pound of lime to each barrel of potatoes absorbs any unpleasant earthy odor. Exposure to light makes potatoes green, bitter and unwholesome. Potatoes taken too early from the ground are apt to heat and sprout when stored.

JERUSALEM ARTICHOKEs. The tuber of a species of sun-flower, This is nutritious, easily digested; makes good soup. Should be stored in boxes of sand as it dries out quickly.

CARROTS are useful as blood purifiers; wholesome, but not very easily digested.

PARSNIPS are more nutritious than carrots, and are best after a touch of frost.

TURNIPS are inferior in nutritive properties.

RADISHES have a stimulating effect upon the excretory organs and act as demulcent; are often given to remove excess of mucus from stomach and bladder.

ASPARAGUS BOILED. 1 large asparagus. Immerse in boiling salted water and cook slowly for about twenty minutes,—drain,—and serve with the following sauce.

Cook together two tablespoons of butter and the same quantity of flour without browning, add slowly stirring constantly, $\frac{1}{2}$ cup of the stock or water in which the asparagus was boiled and $\frac{1}{2}$ cup milk. Season to taste and pour over asparagus.

BEETS WITH THE SAME SAUCE. Boil till tender six small beets, drain and cover with cold water. Mix a cup sugar, 4 tablespoons corn starch, $\frac{1}{2}$ cup vinegar, $\frac{1}{2}$ cup boiling water. Bring all to the boil and pour over beets. Serve either hot or cold.

CARROTS. Boil twelve small carrots, drain and cut in slices, heat gently in melted butter, mix together 1 cup white sauce and 1 cup of green peas and pour over the carrots,—serve very hot.

HORSERADISH SAUCE. 3 tablespoons grated horseradish, 1 tablespoon vinegar, $\frac{1}{4}$ tablespoon salt, dust of cayenne pepper, mix thoroughly and when ready to serve add $\frac{1}{2}$ cup cream, whipped very stiff. To be served with roast beef.

BEAN SALAD. 2 cups cold beans mixed with two tablespoons tomato catsup and covered with 1 tablespoon capers, surround by one cup celery cut in nice pieces. Serve with cettie dressing.

CABBAGE SALAD. 2 cups of cabbage chopped, 1 cup celery, 1 teaspoon cloves or onions grated, 2 drops tobasco sauce or 1 tablespoon tomato catsup. Mayonnaise dressing.

SALAD DRESSING. 2 tablespoons butter creamed. Add one teaspoonful each of salt and sugar, $\frac{1}{2}$ teaspoonful each of mustard and salt. Put into a double boiler. 2 yolks beaten slightly, add 4 tablespoons vinegar and butter mixture—cook till it thickens—and when cold add $\frac{3}{4}$ cup whipped cream.

MAYONNAISE DRESSING. Put the yolk of one egg into a very cold basin, add $\frac{1}{2}$ teaspoon salt and the same quantity of mustard, stir with a silver spoon till the consistency of soft butter, then add drop by drop 1 cup cold olive oil—stirring constantly—when this thickens add 2 tablespoons vinegar, and 1 tablespoon lemon juice, a few drops at a time.

HONEY.

ONE OF NATURE'S BEST FOODS. It is only within the last few centuries that sugar has become known, and only within the last generation that refined sugars have become so low in price that they may be commonly used in the poorest families. Formerly honey was the principal sweet, and it was highly valued three thousand years before the first sugar-refinery was built.

It would add greatly to the health of the present generation if honey could be at least partially restored to its former place as a common article of diet. The almost universal craving for sweets of some kind shows a real need of the system in that direction; but the excessive use of sugar brings in its train a long list of ills. When cane sugar is taken into the stomach, it can not be assimilated until first changed by digestion into grape sugar. Only too often the overtaxed stomach fails to properly perform this digestion, then comes sour stomach and various dyspeptic phases.

Now, in the wonderful laboratory of the hive there is found a sweet that needs no further digestion having been prepared fully by those wonderful chemists, the bees, for prompt assimilation without taxing stomach or kidneys. As Prof. Cook says: "There can be no doubt but that in eating honey our digestive machinery is saved work that it would have to perform if we ate cane sugar; and in case it is overworked and feeble, this may be just the respite that will save from breakdown." A. I. Root says: "Many people who can not eat sugar without having unpleasant symptoms follow will find by careful test that they can eat good well-ripened honey without any difficulty at all."

Not only is honey the most wholesome of all sweets, but it is the most delicious, and its cost so moderate that it may well find a place on the tables of the common people every day in the week.

Indeed, in many cases it may be a matter of real economy to lessen the butter bill by letting honey in part take its place. One pound of honey will go as far as a pound of butter; and if both articles be of the best quality the honey will cost the less of the two.

GIVE CHILDREN HONEY. When children are allowed a liberal supply of honey it will largely do away with the inordinate longing for candy and other sweets.

Ask the average child whether he will have honey alone on his bread, or butter alone, and almost invariably he will answer, "Honey." Yet seldom are the needs or the taste of the child properly consulted. The old man craves fat meat; the child loathes it. He wants sweet, not fat. He delights to eat honey; it is a wholesome food for him, and is not expensive. Why should he not have it?

Honey may be used to sweeten hot drinks, as coffee and tea. German honey-tea—A cup of hot water with one or two tablespoonfuls of extracted honey—is a pleasing and wholesome drink.

CARE OF HONEY.

The average housekeeper will put honey in the cellar for safe keeping—about the worst place possible. Honey readily attracts moisture, and in the cellar extracted honey will become thin, and in time may sour; and with comb honey the case is still worse, for the appearance as well as the quality is changed. Instead of keeping honey in a place moist and cool, keep it dry and warm, even hot. It will not hurt to be in a temperature of even 100°. Where salt will keep dry is a good place for honey. Few places are better than the kitchen cupboard. Up in a hot garret next the roof is a good place, and if it has had enough hot days there through the summer it will stand the freezing of winter; for under ordinary circumstances freezing cracks the combs, and hastens granulation or candying.

CANDIED HONEY. If honey be kept for any length of time, especially during cold weather, it has a tendency to change from its original beautiful liquid transparency to a white semi-solid granular condition; and when it is thus changed, bee-keepers call it “granulated” or “candied.” Sometimes it is candied so solid that when in a barrel the head has to be taken off, and the honey removed by the spade. But its candied condition is not to be taken as an evidence against its genuineness or purity, but rather to the contrary; for the adulterated honeys are less liable to candy than those that are pure. Some prefer honey in the candied state; but the majority prefer liquid.

It is an easy matter to restore it to its former liquid condition. Simply keep it in hot water long enough, *but not too hot*. If heated above 160° there is danger of spoiling the color and ruining the flavor. Remember that honey contains the most delicate of all flavors—that of the flowers from which it is taken. A good way is to set the vessel containing the honey inside another vessel containing hot water, not allowing the bottom of the one to rest directly on the bottom of the other, but putting a bit of shingle or something of the kind between. Let it stand on the stove, but do not let the water boil. It may take half a day or longer to melt the honey. If the honey is set directly on the reservoir of a cook-stove it will be all right in a few days. In time it will granulate.

VARIOUS USES OF HONEY.

Aside from its use in an unchanged state as a direct accompaniment of bread or biscuit, honey is used by bakers in manufacturing some of their choicest wares. An advantage in using honey for anything in the line of cake is its keeping qualities. Even if the cake should become dry, close it up in a bread-can for a time and its freshness will return.

Honey is used in medicines, and is the base of many of the cough cures and salves. For candy, honey is far more wholesome than cane sugar.

Very many of the so-called honey cooking recipes are valueless, for when the ingredients are put together and made into a cake the result is simply vile. The recipes given below have been tested, and every one is guaranteed to be good. The honey-jumble recipe, for instance, is especially good, as is the honey-cake recipe by Maria Fraser.

HONEY COOKING RECIPES.

HONEY-GEMS. 2 qts. flour, 3 tablespoonfuls melted lard, $\frac{3}{4}$ pint honey, $\frac{1}{2}$ pt. molasses, 4 heaping tablespoonfuls brown sugar, $1\frac{1}{2}$ level tablespoonfuls soda, 1 level teaspoonful salt, $\frac{1}{3}$ pint water, $\frac{1}{2}$ teaspoonful extract vanilla.

HONEY-JUMBLES. 2 quarts flour, 3 tablespoonfuls melted lard, 1 pt. honey, $\frac{1}{4}$ pt. molasses, $1\frac{1}{2}$ level tablespoonfuls soda, 1 level teaspoonful salt, $\frac{1}{4}$ pint water, $\frac{1}{2}$ teaspoonful vanilla.

These jumbles and the gems immediately preceding are from recipes used by bakeries and confectioners on a large scale, one firm in Wisconsin alone using ten tons of honey annually in their manufacture.

HONEY-CAKE OR COOKIES without sugar or molasses. Two cups honey; one cup butter; four eggs (mix well); one cup buttermilk (mix); one good quart flour; one level teaspoonful soda or saleratus. If it is too thin, stir in a little more flour. If too thin it will fall. It does not want to be as thin as sugar-cake. I use very thick honey. Be sure to use the same cup for measure. Be sure to mix the honey, eggs and butter well together. You can make it richer if you like by using clabbered cream instead of buttermilk. Bake in a rather slow oven, as it burns very easily. To make the cookies, use a little more flour, so that they will roll out well without sticking to the board. Any kind of flavoring will do. I use ground orange-peel mixed soft. It makes a very nice ginger-bread.

Maria Fraser.

AIKIN'S HONEY-COOKIES. 1 teacupful extracted honey, 1 pint sour cream, scant teaspoonful soda, flavoring if desired, flour to make a soft dough.

SOFT HONEY-CAKE. 1 cup butter, 2 cups honey, 2 eggs, 1 cup sour milk, 2 teaspoonfuls soda, 1 teaspoonful ginger, 1 teaspoonful cinnamon, 4 cups flour.—*Chalon Fowls.*

GINGER HONEY-CAKE. 1 cup honey, $\frac{1}{2}$ cup butter, or drippings, 1 tablespoonful boiled cider, in half a cup of hot water (or $\frac{1}{2}$ cup sour milk will do instead). Warm these ingredients together, and then add 1 tablespoonful ginger and 1 teaspoonful soda sifted in with flour enough to make a soft batter. Bake in a flat pan.—*Chalon Fowls.*

FOWLS' HONEY FRUIT-CAKE. $\frac{1}{2}$ cup butter, Z cup honey, $\frac{1}{3}$ cup apple jelly or boiled cider, 2 eggs well beaten, 1 teaspoonful soda, 1 teaspoon-

ful each of cinnamon, cloves and nutmeg, 1 teacupful each of raisins and dried currants. Warm the butter, honey, and apple jelly slightly, add the beaten eggs, then the soda dissolved in a little warm water; add spices and flour enough to make a stiff batter, then stir in the fruit and bake in a slow oven. Keep in a covered jar several weeks before using.

FOWLS' HONEY LAYER-CAKE. $\frac{2}{3}$ cup butter, 1 cup honey, 3 eggs beaten, $\frac{1}{2}$ cup milk. Cream the honey and butter together, then add the eggs and milk. Then add 2 cups flour containing $1\frac{1}{2}$ teaspoonfuls baking powder previously stirred in. Then stir in flour to make a stiff batter. Bake in jelly-tins. When the cakes are cold, take finely flavored candied honey, and after creaming it spread between layers.

FOWLS' HONEY-COOKIES. 3 teaspoonfuls soda dissolved in 2 cups warm honey, 1 cup shortening containing salt, 2 teaspoonfuls ginger, 1 cup hot water, flour sufficient to roll.

HONEY NUT-CAKES. 8 cups sugar, 2 cups honey, 4 cups milk or water, 1 lb. almonds, 1 lb. English walnuts, 3 cents' worth each of candied lemon and orange peel, 5 cents' worth citron (the last three cut fine), 2 large tablespoonfuls soda, 2 teaspoonfuls cinnamon, 2 teaspoonfuls ground cloves. Put the milk, sugar, and honey on the stove, to boil 15 minutes; skim off the scum, and take from the stove. Put in the nuts, spices, and candied fruit. Stir in as much flour as can be done with a spoon. Set away to cool, then mix in the soda (don't make the dough too stiff). Cover up and let stand over night, then work in flour enough to make a stiff dough. Bake when you get ready. It is well to let it stand a few days, as it will not stick so badly. Roll out a little thicker than a common cooky, cut in any shape you like.

This recipe originated in Germany, is old and tried, and the cake will keep a year or more.—*Mrs. E. Smith.*

HONEY-DROP CAKES. 1 cup honey; $\frac{1}{2}$ cup sugar; $\frac{1}{2}$ cup butter or lard; $\frac{1}{2}$ cup sour milk; 1 egg; $\frac{1}{2}$ tablespoonful soda; 4 cups sifted flour.

HONEY SHORTCAKE. 3 cups flour, 2 teaspoonfuls baking-powder, 1 teaspoonful salt, $\frac{1}{2}$ cup shortening, $1\frac{1}{2}$ cups sweet milk. Roll quickly, and bake in a hot oven. When done, split the cake and spread the lower half thinly with butter, and the upper half with $\frac{1}{2}$ pound of the best flavored honey. (Candied honey is preferred. If too hard to spread well it should be slightly warmed or creamed with a knife). Let it stand a few minutes, and the honey will melt gradually, and the flavor will permeate all through the cake. To be eaten with milk.

HONEY TEA-CAKE. 1 cup honey, $\frac{1}{2}$ cup sour cream, 2 eggs, $\frac{1}{2}$ cup butter, 2 cups flour, scant $\frac{1}{2}$ teaspoonful soda, 1 tablespoonful cream of tartar. Bake 30 minutes in a moderate oven.—*Miss. M. Chandler.*

HONEY GINGER-SNAPS. 1 pint honey, $\frac{3}{4}$ lb. butter, 2 teaspoonfuls ginger. Boil together a few minutes, and when nearly cold put in flour until it is stiff. Roll out thin, and bake quickly.

HONEY FRUIT-CAKE. $1\frac{1}{2}$ cups honey, $\frac{3}{4}$ cup butter, $\frac{1}{2}$ cup sweet milk, 2 eggs well beaten, 3 cups flour, 2 teaspoonfuls baking-powder, 2 cups raisins,, 1 teaspoonful each of cloves and cinnamon.

HONEY POPCORN BALLS. Take 1 pint extracted honey; put it into an iron frying-pan, and boil until very thick; then stir in freshly popped corn, and when cool mold into balls. These will specially delight the children.

HONEY CARAMELS. 1 cup extracted honey of best flavor, 1 cup granulated sugar, 3 tablespoonfuls sweet cream or milk. Boil to "soft crack," or until it hardens when dropped into cold water, but not too brittle—just so it will form into a soft ball when taken in the fingers. Pour into a greased dish, stirring in a teaspoonful extract of vanilla just before taking off. Let it be $\frac{1}{2}$ or $\frac{3}{4}$ inch deep in the dish; and as it cools cut in squares and wrap each square in paraffine paper, such as grocers wrap butter in. To make chocolate caramels, add to the foregoing 1 tablespoonful melted chocolate, just before taking off the stove, stirring it in well. For chocolate caramels it is not so important that the honey be of best quality.—*C. C. Miller.*

HONEY APPLE-BUTTER. One gallon good cooking apples; 1 quart honey; 1 quart honey vinegar; 1 heaping teaspoonful ground cinnamon. Cook several hours, stirring often to prevent burning. If the vinegar is very strong, use part water.

Mrs. R. C. Aikin.

HONEY AND TAR COUGH-CURE. Put 1 tablespoonful liquid tar into a shallow tin dish and place it in boiling water until the tar is hot. To this add a pint of extracted honey and stir well for half an hour, adding to it a level teaspoonful pulverized borax. Keep well corked in a bottle. Dose, teaspoonful every one, two, or three hours, according to severity of cough.

SUMMER HONEY-DRINK. 1 spoonful fruit juice and 1 spoonful honey in $\frac{1}{2}$ glass water; stir in as much soda as will lie on a silver dime, and then stir in half as much tartaric acid, and drink at once.

HONEY VINEGAR. Honey vinegar can be made by using $1\frac{1}{2}$ ounces of honey to 1 gallon of clear soft water. Store in a barrel or other vessel. It should be kept in a warm place, with an opening in the vessel to allow the air to circulate freely, thus causing it to come to perfection more quickly. At the end of the year it will be ready for use. Its keeping qualities are excellent, and the best of pickles can be made with it. There is, perhaps, nothing superior for using with vegetable and meat salads.

Ontario Department of Agriculture.

FRUIT EXPERIMENT STATIONS.

FRUIT RECOMMENDED FOR PLANTING.

IN VARIOUS PARTS OF THE PROVINCE OF ONTARIO, AFTER CAREFUL TESTS
OF VARIETIES MADE AT THE VARIOUS FRUIT EXPERIMENT STATIONS.

FRUIT EXPERIMENT STATIONS.

BOARD OF CONTROL, 1906.

G. C. CREELMAN, B.S.A., President of Agricultural College, Guelph, *Chairman*.
H. L. HUTT, B.S.A., Professor of Horticulture, Guelph.
W. T. MACOUN, Horticulturist at Central Experimental Farm, Ottawa.
ELMER LICK, Director of Ontario Fruit Growers' Association, Oshawa.
A. M. SMITH, Director of Ontario Fruit Growers' Association, Port Dalhousie.
P. W. HODGETTS, Sec'y of the Ontario Fruit Growers' Association, Toronto.
LINUS WOOLVERTON, M.A., Grimsby, *Secretary*.

THE ONTARIO FRUIT STATIONS.

Name.	Fruit.	Experimenter.
1 Southwestern..	Peaches	W. W. HILBORN, Leamington.
2 Wentworth....	Grapes	MURRAY PETTIT, Winona.
3 Burlington....	Blackberries and Currants ...	A. W. PEART, Burlington.
4 Lake Huron...	Raspberries	A. E. SHERRINGTON, Walkerton.
5 Georgian Bay.	Plums	J. G. MITCHELL, Clarksburg.
6 Simcoe.....	Hardy Apples and Hardy Cherries	G. C. CASTON, Craighurst.
7 Bay of Quinte..	Apples	W. H. DEMPSEY, Trenton.
8 St. Lawrence...	Hardy Plums and Hardy Pears	HAROLD JONES, Maitland.
9 Strawberry Station.....	.....	E. B. STEVENSON, Ponsonby.
10 Maplehurst....	Cherries, Peaches, Pears, Plums, and other tender fruits; also a general col- lection of fruits for descrip- tive work for "Fruits of Ontario".....	L. WOOLVERTON, Grimsby.
11 Algoma.....	Hardy fruits	CHAS. YOUNG, Richard's Landing.

EXPLANATORY REMARKS.

General Lists. After testing a large number of varieties of fruit at the various fruit stations, the Board of Control has decided upon the following as the most desirable for general planting.

District Lists. The District Lists given by the various experimenters show varieties especially adapted to the sections represented by their stations.

The term *Commercial* is intended to include the varieties most desirable for market purposes and the term *Domestic* those most desirable for home uses, either cooking or dessert.

These lists are given, as far as possible, in the order of ripening.

It is realized that there are many varieties not included in these lists which may do well *under special conditions*, yet which are generally not considered as desirable as those mentioned.

The Board of Control recognizing the great disadvantage which faces inexperienced persons who desire to engage in fruit growing for profit, because of the very large and confusing list of varieties, has ordered the publication of select lists of tested varieties which shall serve as a guide to intending planters.

APPLES.

GENERAL LIST OF THE MOST VALUABLE VARIETIES FOR MARKET APPROVED
BY THE BOARD OF CONTROL.

Summer.

Astrachan: Adapted to all sections except the extreme north.

Duchess: Adapted to all sections.

Fall.

Gravenstein: Adapted to all sections except the St. Lawrence River and other northerly portions of the Province.

Wealthy: Particularly valuable for northern sections.

Alexander: Especially for northern districts.

McIntosh: Adapted especially to the St. Lawrence River district, but can be grown over a much wider area.

Fameuse: Adapted especially to the St. Lawrence River district, but succeeds well over a much wider area.

Blenheim: Adapted to all sections except the St. Lawrence River district and other northerly portions of the Province.

Winter.

King: Adapted only to the best apple sections, and succeeds best when top grafted on hardy stocks.

Hubbardston: Adapted to the best apple sections.

Greening: Adapted to the best apple sections.

Baldwin: Succeeds best on clay land, and is adapted to the best apple districts.

Northern Spy: Adapted to the best apple districts, but can be grown with success farther north by top-grafting on hardy stocks. This is also a good method of bringing it into early bearing.

Ontario: An early and abundant bearer, but short lived. Recommended as a filler among long lived trees. Adapted to same districts as *Northern Spy*, which it somewhat resembles.

Stark: Adapted to best apple districts.

VARIETIES ESPECIALLY ADAPTED TO HOME USE.

Summer.

Transparent: Adapted to all sections.

Primate: Adapted to best apple sections.

Sweet Bough: Adapted to best apple sections.

Duchess: Adapted to all sections.

Fall.

Chenango: Adapted to best apple sections.

Gravenstein: Adapted to best apple sections.

Wealthy: Especially adapted to northern sections.

McIntosh: Especially adapted to northern sections.

Fameuse: Especially adapted to northern sections.

Blenheim: Adapted to best apple sections.

Winter.

King: Adapted to best apple sections. Should be top grafted.

Wagener: Adapted to best apple sections.

Swayzie: Adapted to all sections except most northerly.

Greening: Adapted to best apple districts.

Tolman: Adapted to best apple districts.

Northern Spy: Adapted to best apple districts, but will succeed farther north if top grafted.

Mann: Adapted to best apple districts, but will succeed farther north if top grafted.

HARDY VARIETIES RECOMMENDED FOR SECTIONS NORTH OF LATITUDE 46 DEGREES.

Summer.

Yellow Transparent, Charlamoff.

Fall and Winter.

Duchess, Wealthy, Hiberna, Longfield, Patten, Whitney, Hyslop, Scott Winter.

CRABS SUITABLE FOR THE WHOLE OF THE PROVINCE.

Whitney : A large crab of high quality, suitable for planting in the extreme north where other apples will not succeed. May be used for dessert or cooking.

Martha : An early crab of fair quality.

Transcendent : Yellowish crab, season early autumn.

Hyslop : Dark, rich, red crab, of late season, quality only fair.

DISTRICT LISTS RECOMMENDED BY THE EXPERIMENTERS.

Niagara District : By Linus Woolverton, Grimsby, Ont.

Commercial : Astrachan, Duchess, Gravenstein, Alexander, Blenheim, Cranberry, Hubbardston, King, Greening, Baldwin, Spy.

Domestic : Early Harvest, Sweet Bough, Duchess, Chenango, Gravenstein, Shiawassee, Fall Pippin, Fameuse, Swayzie, Wagener, Yellow Bellflower, Esopus (Spitzenburg), Tolman.

Bay of Quinte District : By W. H. Dempsey, Trenton, Ont.

Commercial : Duchess, Gravenstein, Trenton, Alexander, Wealthy, Fameuse, McIntosh, King, Greening, Baldwin, Ontario, Seek, Spy, Tolman, Ben Davis, Stark.

Domestic : Benoni, Primate, Gravenstein, Fameuse, McIntosh, Grimes, Greening (R.I.), Ontario, Spy, Tolman, Swayzie.

Burlington District : By A. W. Peart, Burlington, Ont.

Commercial : Astrachan, Duchess, Wealthy, Ribston, Blenheim, King, Greening, Baldwin, Spy.

Domestic : Astrachan, Sweet Bough, Gravenstein, Wagener, Seek, Golden Russet.

Lake Simcoe District : By G. C. Caston, Craighurst, Ont.

Commercial : Duchess, Peerless, Alexander, Wolf, Blenheim, Pewaukee, Stark, and the following if top-worked on hardy stocks : Greening, King, Ontario, Baldwin, Spy.

Domestic : Astrachan, Primate, St. Lawrence, Fameuse, McIntosh, King, Spy.

Lake Huron District : By A. E. Sherrington, Walkerton, Ont.

Commercial : Astrachan, Duchess, Wealthy, Fameuse, McIntosh, Blenheim, Greening, Baldwin, Spy, Golden Russet, Ben Davis.

Domestic : Transparent, Astrachan, Duchess, McIntosh, Grimes, Blenheim, King, Spy, Golden Russet.

St. Lawrence District : By Harold Jones, Maitland, Ont.

Commercial : Duchess, Alexander, Wolf, Scarlet Pippin, Fameuse, McIntosh, Baxter, Milwaukee, Golden Russet.

Domestic : Transparent, Brockville Beauty, Scarlet Pippin, Fameuse, McIntosh, Blue Pearmain, Golden Russet, Yellow Bellflower.

Algoma District : By Charles Young, Richard's Landing, Ont.

Commercial and Domestic : Astrachan, Transparent, Duchess, Charlamoff, Gideon, Longfield, Wealthy, Scott Winter.

BLACKBERRIES.

GENERAL LIST, APPROVED BY THE BOARD OF CONTROL.

Agawam, Snyder, Eldorado, and for southern sections, Kittatinny.

DISTRICT LISTS RECOMMENDED BY THE EXPERIMENTERS.

Burlington District : By A. W. Peart, Burlington, Ont.

Commercial and Domestic : Snyder, Ancient Briton, Western Triumph, Agawam, Taylor.

Lake Simcoe District : By G. C. Caston, Craighurst, Ont.

Commercial and Domestic : Agawam, Eldorado.

CHERRIES.

GENERAL LIST, APPROVED BY THE BOARD OF CONTROL.

Hardy : Orel 25, Orel 24, Early Richmond, Montmorency, Russian 207.

DISTRICT LISTS, RECOMMENDED BY THE EXPERIMENTERS.

Niagara District : By Linus Woolverton, Grimsby, Ont.

Commercial : Wood, Knight, Napoleon, Tartarian, Dyehouse, Montmorency, Late Duke, Elkhorn, Windsor, English Morello.

Domestic : May Duke, Cleveland, Knight, Elton, Tartarian, Hortense, Choisy, Black Eagle, Mezel, Royal Duke.

Lake Simcoe District : By G. C. Caston, Craighurst, Ont.

Commercial and Domestic : Orel 24, Ostheim, Lithaur, Russian 207, Bessarabian, Dyehouse, English Morello.

Algoma District : By Charles Young, Richard's Landing, Ont.

Commercial and Domestic : Early Richmond, Montmorency, English Morello.

Bay of Quinte District : By W. H. Dempsey, Trenton, Ont.

Commercial and Domestic : Early Richmond, Montmorency.

St. Lawrence District : By Harold Jones, Maitland, Ont.

Commercial and Domestic : Early Richmond, Montmorency, Orel 24, English Morello.

CURRENTS.

GENERAL LIST, APPROVED BY THE BOARD OF CONTROL.

Black : Black Victoria, Champion, Lee, Naples, Saunders.

Red : Cherry, Fay, Pomona, Red Cross, Victoria, Wilder.

White : White Grape.

DISTRICT LISTS, RECOMMENDED BY THE EXPERIMENTERS.

Burlington District : By A. W. Peart, Burlington, Ont.

Commercial : *Black :* Lee, Naples, Saunders.

Red : Cherry, Fay, North Star, Prince Albert, Victoria, Wilder.

White : White Grape.

Lake Huron District : By A. E. Sherrington, Walkerton, Ont.

Black : Champion, Naples, Saunders.

Red : Pomona, Red Cross.

GOOSEBERRIES.

GENERAL LIST, APPROVED BY THE BOARD OF CONTROL.

Pearl, Downing, Red Jacket. Whitesmith is one of the best English varieties, but is almost valueless on some soils and in some localities owing to mildew.

GRAPES.

GENERAL LIST, APPROVED BY THE BOARD OF CONTROL.

*Commercial and Domestic :**Black :* Moore, Campbell, Worden, Concord, Wilder.*Red :* Delaware, Lindley, Agawam, Vergennes.*White :* Niagara, Diamond.*For Northern Sections :**Black :* Champion, Moore, Campbell, Worden, Wilder.*Red :* Moyer, Brighton, Delaware, Lindley.*White :* Winchell, Diamond.

DISTRICT LISTS, RECOMMENDED BY THE EXPERIMENTERS.

Wentworth District : By M. Pettit, Winona, Ont.

*Commercial :**Black :* Champion, Moore, Campbell, Worden, Concord.*Red :* Delaware, Lindley, Agawam, Vergennes, Catawba.*White :* Niagara, Diamond.*Domestic :**Black :* Black Delaware, Early Dawn.*Red :* Jefferson, Mills.*White :* Winchell, Golden Drop.**Niagara District :** By Linus Woolverton, Grimsby, Ont.*Domestic :* Moyer, Campbell, Worden, Delaware, Lindley, Brighton, Wilder, Agawam, Requa.

PEACHES.

GENERAL LIST, APPROVED BY THE BOARD OF CONTROL.

*Commercial :**Sneed :* Whitefleshed, clingstone, quality only fair, earliest of all.*Alexander :* Whitefleshed, clingstone.*Hynes :* Whitefleshed, semicling, quality good.*St. John :* Yellowfleshed, freestone, quality good.*Mountain Rose :* Whitefleshed, freestone, quality very good.*Early Crawford :* Yellowfleshed, freestone, quality very good.*Champion :* Whitefleshed, freestone, quality very good, for home use, or near markets.*Brigdon :* Yellowfleshed, freestone, quality good.*Fitzgerald :* Yellowfleshed, freestone, quality very good.

Reeves : Yellowfleshed, freestone, quality fair, large size.

Elberta : Yellowfleshed, freestone, quality fair, good for long distance shipments.

Oldmixon : Whitefleshed, freestone, quality good.

Stevens : Whitefleshed, freestone, quality good.

Smock : Yellowfleshed, freestone, quality fair, very late, good shipper.

Domestic :

Hynes, St. John, Early Crawford, Oldmixon, Longhurst, Stevens.

DISTRICT LISTS, RECOMMENDED BY THE EXPERIMENTERS.

Niagara District : By Linus Woolverton, Grimsby, Ont.

Commercial : Sneed, Alexander, Greensboro, St. John, Early Crawford, New Prolific, Champion, Elberta, Willet, Smock.

Domestic : Rivers, Hynes, St. John, Early Michigan, Lewis, Crosby, Champion, Reeves, Wonderful, Jacques Rareripec, Wheatland, Longhurst.

Essex District : By W. W. Hilborn, Leamington, Ont.

Commercial : Alexander, St. John, Brigdon, Early Crawford, Fitzgerald, New Prolific, Engol, Elberta, Golden Drop, Kalamazoo, Banner, Smock.

Domestic (Whiteflesh) : Alexander, Mountain Rose, Oldmixon, Stevens.

(Yellowflesh) : St. John, Early Crawford, Fitzgerald, New Prolific, Engol, Crosby, Golden Drop, Banner.

PEARS.

GENERAL LIST, APPROVED BY THE BOARD OF CONTROL.

Commercial : Giffard, Clapp, Bartlett, Boussock, Flemish (hardy, subject to spot), Howell, Louise, Duchess, Bosc, Clairgeau, Anjou, Kieffer.

Domestic : Summer Doyenne, Giffard, Bartlett, Flemish (for the north), Sheldon, Seckel, Bosc, Anjou, Lawrence, Josephine, Winter Nelis.

DISTRICT LISTS, RECOMMENDED BY THE EXPERIMENTERS.

Niagara District : By Linus Woolverton, Grimsby, Ont.

Commercial : Chambers, Wilder, Giffard, Clapp, Bartlett, Hardy, Bosc, Howell, Louise, Duchess, Pitmaston, Clairgeau, Anjou, Easter Beurre.

Domestic : Doyenne, Manning, Giffard, Boussock, Rostiezer, Marguerite, Sheldon, Seckel, Triumph, Ritson, Louise, Hardy, Diel, Anjou, Lawrence.

Burlington District : By A. W. Peart, Burlington, Ont.

Commercial : Wilder, Clapp, Bartlett, Boussock, Louise, Duchess (dwarf), Anjou, Kieffer, Winter Nelis, Easter Beurre.

Domestic : Wilder, Bartlett, Louise, Anjou, Winter Nelis.

Bay of Quinte District : By W. H. Dempsey, Trenton, Ont.

Commercial and Domestic : Giffard, Tyson, Clapp, Boussock, Hardy, White Doyenne, Dempsey, Bosc, Clairgeau, Goodale, Lawrence, Josephine.

St. Lawrence District : By Harold Jones, Maitland.

Domestic : Clapp, Flemish, Ritson.

PLUMS.

GENERAL LIST, APPROVED BY THE BOARD OF CONTROL.

Commercial and Domestic :

American : These are extremely hardy and are desirable where the European and Japanese varieties cannot be grown : Aitkin, Cheney, Bixby, Mankato, Wolf, Hawkeye, Stoddard.

European : Bradshaw, Imperial Gage, Gueii, Shipper's Pride, Lombard (liable to over bear, requires thinning), Quackenboss, Yellow Egg, Grand Duke, Golden Drop (Coe), Reine Claude (one of the best for canning).

Japanese : These are apparently quite as hardy as the European varieties : Red June, Abundance, Burbank, Chabot, Satsuma (red fleshed, desirable for canning).

DISTRICT LISTS, RECOMMENDED BY THE EXPERIMENTERS.

Lake Huron District : By A. E. Sherrington, Walkerton, Ont.

Commercial and Domestic : Red June, Ogon, Burbank, Bradshaw, Imperial Gage, Gueii, Shipper's Pride, Victoria, Quackenboss, Yellow Egg, Monarch, Grand Duke, Satsuma.

Georgian Bay District : By John Mitchell, Clarksburg.

Commercial and Domestic : Red June, Burbank, Washington, Bradshaw, Imperial Gage, Quackenboss, Arch Duke, Diamond, Monarch, Yellow Egg, Golden Drop (Coe), Satsuma, Reine Claude.

Burlington District : By A. W. Peart, Burlington, Ont.

Commercial :

European : Bradshaw, Niagara, Imperial Gage, Lombard, Yellow Egg, Glass, Reine Claude.

Japan : Red June, Abundance, Burbank, Chabot, Satsuma.

Domestic : Abundance, Saunders, Bradshaw, Imperial Gage, Smith Orleans, Lombard, Yellow Egg, Satsuma, Reine Claude.

Niagara District : By Linus Woolverton, Grimsby, Ont.

Commercial : Red June, Burbank, Bradshaw, Chabot, Gueii, Golden Drop (Coe), Quackenboss, Satsuma, Reine Claude.

Domestic : Abundance, Washington, Yellow Egg, Shropshire, Quackenboss, Satsuma, Reine Claude.

St. Lawrence District : By Harold Jones, Maitland, Ont.

Domestic :

European : Gueii, Lombard, Shipper's Pride, Glass.

Japan : Red June, Burbank.

American : Milton, Whitaker, Hammer.

QUINCES.

GENERAL LIST, APPROVED BY THE BOARD OF CONTROL.

Fuller, Orange (the leading market variety in Ontario), Champion (for Southern Ontario only as it ripens too late for other sections).

RASPBERRIES.

GENERAL LIST, APPROVED BY THE BOARD OF CONTROL.

Black : Hilborn, Older, Gregg, Smith Giant.

Purple : Columbian, Shaffer.

Red : Marlboro,, Herbert, Cuthbert.

White : Golden Queen.

DISTRICT LISTS, RECOMMENDED BY THE EXPERIMENTERS.

Lake Huron District : By A. E. Sherrington, Walkerton, Ont.

Commercial and Domestic :

Black : Hilborn, Conrath, Older.

Purple : Columbian, Shaffer.

Red : Marlboro, Herbert, Cuthbert.

STRAWBERRIES.

GENERAL LIST, APPROVED BY THE BOARD OF CONTROL.

Commercial : Splendid (Perfect), Bederwood (P.), Warfield (Imperfect), not suited to light sandy soil, Greenville (Imp.), Williams (P.), Saunders (P.), Sample (Imp.), Irene (Imp.), Buster (Imp.).

Domestic : Van Deman (P.), Splendid (P.), Excelsior (P.), Senator Dunlap (P.), Ruby (P.), Bubach (Imp.), Irene (Imp.), Belt (P.), Lovett (P.).

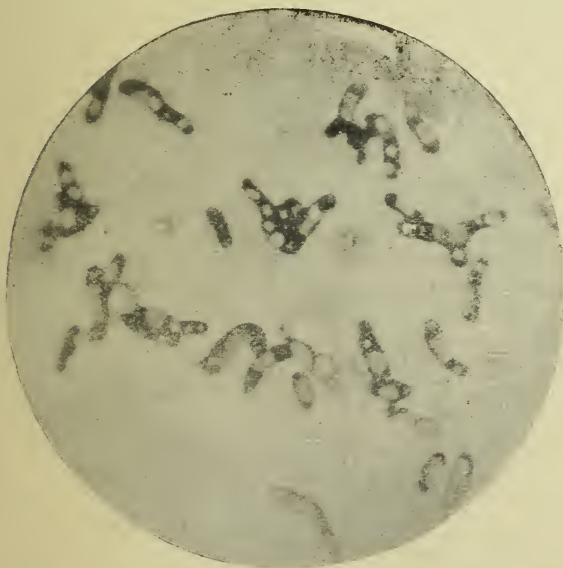
NOTE.—In selecting varieties for planting, perfect-flowered varieties should be included to fertilize those having imperfect flowers.

Ontario Department of Agriculture.

ONTARIO AGRICULTURAL COLLEGE AND EXPERIMENTAL FARM

CO-OPERATIVE EXPERIMENTS WITH NODULE-FORMING BACTERIA.

BY F. C. HARRISON AND B. BARLOW.



The nodules-forming, and nitrogen-fixing bacteria.
(Magnified 1,500 times.)

The issue of a number of bulletins by the United States Department of Agriculture on "Beneficial Bacteria for Leguminous Crops," "Inoculation of Soil with Nitrogen-fixing Bacteria," and the publication of articles on this subject in some of the popular magazines, has called the attention of the Canadian farming community to the maintenance of soil fertility by the growth of legumes which have been treated with beneficial bacteria, and has resulted in the many requests for information to the Bacteriological Department of the College with demands for samples of the necessary bacteria for the purpose of treating various crops such as clovers, peas, beans, etc.

Hence, it seemed necessary to publish a report of what has been accomplished in this line at Guelph, together with a brief statement of the history of the discovery of the legume bacteria, their manner of growth, and how they may be utilized by the farmer.

THE IMPORTANCE OF NITROGEN TO THE FARMER.

As is well known, nitrogen, the most important and costliest element that a farmer buys or uses for plant food, can be used by most plants combined only in the form of nitrates. The daily loss of this valuable fertilizer is enormous, and several scientists have predicted that in the course of a number of years our supply of nitrogen will be so appreciably used up that the growing of wheat and other crops will be a matter of difficulty. These men base their calculations on the loss of nitrogen which comes from the yearly cropping of land, the waste of the sewage from the great centres of populations, the loss by leaching from the soil, the action of the denitrifying bacteria, and other causes; and they also show that the great natural stores of this element are being quickly consumed for agricultural purposes. Thus the guano deposits are nearly all used up, and the South American saltpetre beds are being fast exhausted. Fortunately, however, there are vast stores of nitrogen in the air, the atmosphere containing about four out of every five parts of this element, and one of the great problems of modern agriculture has been to make this store of atmospheric nitrogen available to plants, and the peculiar ability of leguminous plants to assimilate the nitrogen of the air is the faculty which makes them so valuable to the farmer. The legumes are able to achieve this result by the aid of the bacteria which are associated with them in the nodules or tubercles on their roots.

Not only does the acquirement of the nitrogen from the air benefit the legume, but it also enriches the soil and renders available considerable combined nitrogen for the use of succeeding crops. Every practical farmer acknowledges these facts by introducing clover or some other legume in his rotation, knowing that the fertility of his soil is thus increased. As a result of the investigation of many Experiment Stations it has been shown that from 100 to 200 pounds per acre of nitrogen are added to the soil by the growth of a crop of legumes. Putting the matter into dollars and cents, the United States Department of Agriculture states that a crop of nodule-bearing legumes is equal to from 800 to 1,000 pounds of nitrate of soda per acre, which at the present rate for this fertilizer represents a value of from \$20.00 to \$25.00.

THE DISCOVERY OF THE NODULE BACTERIA

The Romans were fully aware of the importance of growing legumes, and introduced such crops into their rotations, many writers in their time drew attention to the manure-like qualities of beans, vetches, etc. Thus, Pliny, a Roman writer, makes the definite statement that beans will fertilize the soil of a field or vineyard as well as the very best manure. The true reason of these facts was, of course, not known at that time, but was

attributed to the greater root development of the legumes and, in consequence, their ability to obtain more nourishment from the soil.

The tubercles or nodules on the roots of clovers, peas, etc., had been noticed for a considerable time (since 1687). Some thought they were of parasitic origin, and others saw in them simply excrescences or galls, and a few thought they were the normal growths of the plant; and it was not until 1886 that two German scientists, Hellriegel and Willfarth, showed that the development of the root nodules was intimately connected with the growth of the whole plant, and that the assimilation of the nitrogen of the atmosphere by legumes was associated with the development of the nodules or tubercles on the roots. Later investigators confirmed these results, and these discoveries were quickly followed by the detection of the bacteria in the nodules, their isolation and growth on artificially prepared food and the ability of these cultivated organisms to produce other nodules when brought into contact with suitable legumes growing in sterilized or germ free soil.

The first practical applications of these discoveries was the introduction of cultures or growths of these bacteria for application to the seeds of the various legumes. The trade name of *Nitragin* was given by Nobbe, the inventor of this method, to these cultures, and the product was extensively advertised and exploited by a German firm of manufacturing chemists. Numerous experiments were conducted with this material. Some succeeded and others failed, but after a few years' trial the manufacturers discontinued the sale of this article.

About 1902 the study of the root-nodule organism was undertaken by the Laboratory of Plant Physiology of the United States Department of Agriculture, and they perfected a method by which these organisms could be sent out to farmers and used for inoculating seed. Up to November 1904, over 12,000 packages of inoculating material were distributed, and the reports of 3,540 experimentors showed that 79 per cent. of these were successful.

Recently, however, some complaint has been made concerning the quality of the cultures sent out by the U. S. Department of Agriculture, the New York Experiment Station reporting the results of a bacteriological examination of 18 packages of treated cotton (the nodule-forming bacteria dried upon absorbent cotton) in which no living nodule bacteria were found.

The failure of these cultures was due to their method of preparation, but the N. Y. Experiment Station state that "they should not be understood as being opposed to the idea of treating the seed of legumes with living bacteria."

DISTRIBUTION OF CULTURES IN CANADA.

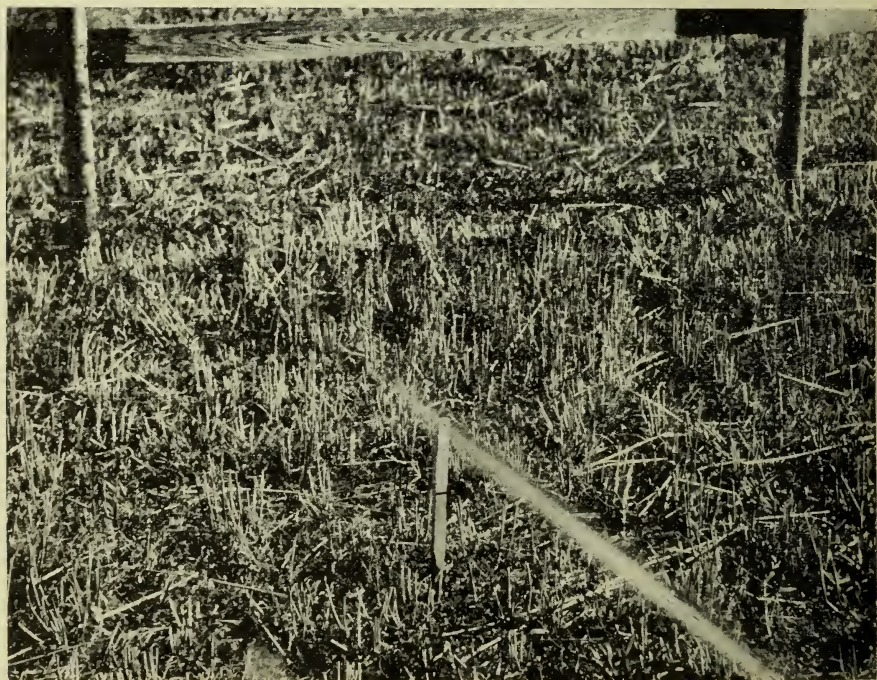
During the spring of 1905, the Bacteriological Department of the Ontario Agricultural College sent out a number of samples of the nodule-forming bacteria for experimental purposes. These samples were sent out in small bottles, in such condition that all the farmer had to do was to mix the contents of the bottle with a measured quantity of water, and then apply to his seed; this method doing away with the "building up" process

advocated by the U.S. Department of Agriculture, in which a package of treated cotton, containing dried bacteria, has to be put into a solution of chemicals, and the bacteria allowed to develop for a day or two before being applied to the seeds.

These samples were sent all over Canada, from Prince Edward Island to British Columbia, the number of cultures being as follows :

Ontario.....	76	Assiniboia	13
Nova Scotia.....	66	Alberta	12
New Brunswick.....	11	British Columbia	15
P. E. Island	17	United States	2
Cape Breton	1		
Quebec	10	Total.....	246
Manitoba.....	23		

They were also tested by Mr. Frank T. Shutt, Chemist, Experimental Farm, Ottawa ; by Principal M. Cumming, Agricultural College, Truro, N.S., by Mr. C. Jarvis, Assistant to Prof. L. H. Bailey, of Cornell Experiment Station, and by ourselves. At the end of the season a circular



Plot of alfalfa or lucerne, grown from seed untreated with nitro-culture. The mark on upright stick shows height to which the alfalfa grew in the adjoining treated plot. (Experiment conducted by Principal Cumming, Agricultural College, Truro, N.S.)

letter was sent to all who had received cultures, asking what success each experimenter had had. These reports may be summarized thus :—

Crop.	Total No. of reports received.	Inoculation successful, with increased growth of crop.	Organisms already present in the soil.	No advantages from inoculation.
Lucerne or alfalfa	59	43	1	15
Red Clover	47	31	1	15
Peas	12	7	1	4
Beans	9	5	..	4
Alsike.....	2	1	..	1
White Clover.....	1	1	..	..
Vetch	3	2	..	1
Soy Bean.....	1	1	..	..
	134	91	3	40



Alfalfa or Lucerne. Plot grown from seed treated with alfalfa nitro-culture. The stick in the centre of the plot is covered up to ten inches from the ground with alfalfa plants. (Experiment conducted by Principal Cumming, Agricultural College, Turro, N.S.)

In order to give the farmers an idea of these reports, a number of extracts are given from them which show the benefit some experimenters have obtained from the use of the nitro-cultures :

Taylor Village, N.B. I put three acres with the treated seed and three acres without the nitro-culture on a piece of heavy land, and in examining the plants from time to time I found that nodules were quite plentiful on the plants from the treated seed, and none on the plants from the untreated seed, and I also found the growth and thriftiness quite marked in favor of the plants from the nitro-treated seed. (Red Clover.)

River John, N.S. The plants from the treated seed were thicker and thriftier than those without the nitro-cultures, which were thin and spindly. The roots on the treated spot being loaded with nodules and very fibrous, while on the untreated there is far less root growth. (Red Clover.)

Marshville, Ont. Enclosed please find samples of what I pulled this morning (July 4th) in different parts of the field, which I think is very satisfactory indeed. Nodules appeared when plants were just above ground. What I sowed in spring of 1904 has no nodules. (Red Clover.)

NOTE.—The one sample showed numerous nodules, the other none.—Authors.

Colwood, B.C. The part treated with nitro-culture looks green and more vigorous than the untreated. Nodules are numerous on the treated portion. (Red Clover.)

Fingal, Ont. The rootlets of the plants treated with nitro-culture were simply clustered with nodules. Without nitro-culture, nodules were not so numerous, but were present. (Red Clover.)

Colina, B.C. The clover plants were a lot better on the treated land. (Red Clover.)

Emerson, Man. On some plants treated the nodules were quite numerous. Those having nodules were very vigorous, but the others have made but small growth. (Red Clover.)

Neepawa, Man. The vigor of plants from seed treated with nitro-culture was very good. The untreated seed produced pale and short plants. (Red Clover.)

Edmonton, Alta. Numerous nodules on plants from treated seed and very healthy stand. With the untreated seed the plants were sickly with a few healthy stalks. (Red Clover.)

Deep Brook, N.S. Soon after seeding I commenced examining plants on the treated patch and found nodules present which increased in size and number each week as the season advanced. There was a marked difference between the plants from treated and untreated seed in favor of the former. (Red Clover.)

Berwick, N.S. The plants from treated seed were quite vigorous, those from untreated only half as high. (Red Clover.)



Root of Sanfoin, showing nodules.

Cypress River, Man. Plants from treated seed very strong with numerous nodules, without nitro-culture much smaller and weaker. (Red Clover.)

Stamford, Ont. Vigor of plants from treated seed good, without nitro-culture no catch. (Red Clover.)

Meadowville, N.S. Very vigorous plants with numerous nodules from the treated seed, only fair stand from untreated. (Red Clover.)

Port Williams, N.S. In the early part of the season the division line between the inoculated plants and the uninoculated was very marked.

Nodules were very numerous on the treated plants but only a few present on some of the untreated. (Red Clover.)

Naweg, N.B. Very vigorous and numerous nodules from the treated seed; not nearly so vigorous without the nitro-culture. (Beans.)

Cedar Springs, Ont. I am convinced the application was a success. (Beans.)

Mount Salem, Ont. The nodules on the beans not treated were small, about the size of pin-heads, and pods on plants were short. On the plants treated the nodules were as large as small peas, growing tight against one another. The pods on the plants were longer and the plants withstood dry weather better than those not treated, being green and flourishing when the others were dried up. The beans when ripe were bright and even in the pods. I exhibited half a bushel of these at the East Elgin Fair and secured first prize on them. (Beans.)

Cedar Springs, Ont. The nodules were larger and more numerous on the plants from the treated seed. Those of the untreated had nodules, but they were not so large and easily one-third less in number. (Beans.)

Cross Roads, N.S. Nodules present on the plants from treated seed, fairly vigorous growth. Without nitro-culture the plants were poor and no nodules were present. (Vetch.)

Waterville, N.S. The plants from treated seed were very strong, many roots were a solid mass of nodules. From untreated seed plants were not so good and had very few nodules. (Vetch)

Rapid City, Man. Plants from treated seed strong, numerous nodules; from untreated seed plants only about half as big. (Alsike clover.)

Barrie, Ont. I found the culture very satisfactory, the yield of peas being fully ten per cent. more from the seed treated with culture. (Peas.)

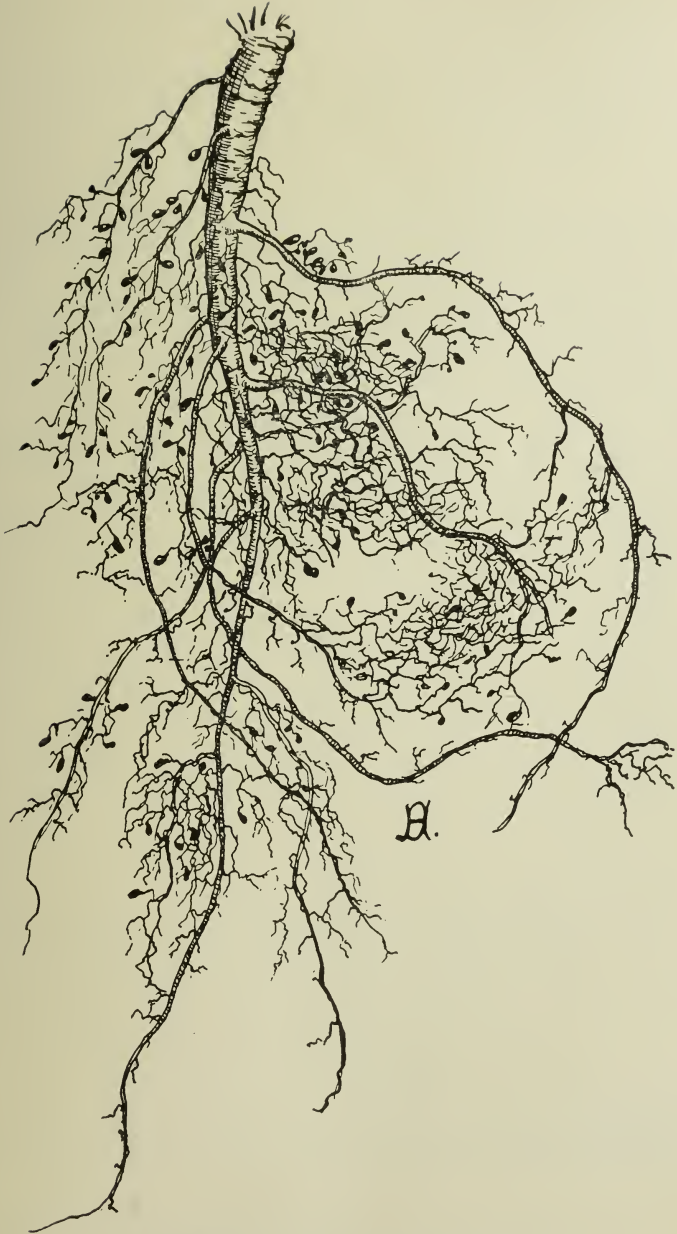
Ruthven, Ont. Very vigorous plants from the treated seed with numerous nodules. Without treatment the plants were about the usual size and few nodules. (Peas.)

Colquitz, B. C. I find that in the portion of ground where this culture was used, plants seem to be thriving and have the nodules on the roots, while, at the same time, on ground seeded to alfalfa close by on which the culture was not used, the plants are sickly looking and have no nodules upon the roots. (Alfalfa.)

Lion's Head, Ont. The alfalfa seed sown by me this spring, and treated with nitro-culture obtained from you, has grown without a check. That without the culture came up in patches, but did no more. As the alfalfa has failed here before I attribute my success to the culture. (Alfalfa.)

Round Hill, N. S. From treated seed the growth of plants was 25 inches, from seed untreated about one inch. (Alfalfa.)

Windsor Mills, Que. Plants from treated seed strong and healthy, those without nitro-culture only fair.



Root of Red Clover, showing nodules.

Harding, Man. There was quite a marked difference between what was treated and what was not treated, and I consider the result was very good. (Alfalfa.)

Mount Stewart, P. E. I. Plants from treated seed were dark green and quite vigorous. From untreated seed the plants were yellow and unthrifty. (Alfalfa.)

Colquitz, B.C. I am not a believer in nitro-culture, or, at least, was very skeptical as to the treatment being of any value whatever. I have been unable, however, to shut my eyes to the fact as shown by my own land. The land had been well sub-soiled in preparation to a depth of from 16 to 18 inches, and the portion upon which the nitro-culture was not used was treated in every way as well as the other. The plants from the treated seed were very strong and sown with nurse crop are now about 8 inches high. From untreated seed the plants are weak in appearance and only about 3 inches high. (Alfalfa.)

Centretown, Ont. The plants from treated seed sown on very light sandy soil were healthy and grew rapidly. Those from untreated seed were delicate and of stunted growth. (Alfalfa.)

Cloverdale, B.C. Plants from treated seed are healthy in color and 18 inches high, from untreated seed 4 to 6 inches high and yellow. I may say in conclusion that the quarter acre of untreated seed was planted on better land which had been under cultivation in root crops for two years and had been slightly manured with barnyard manure and lime previously. The treated seed was planted on absolutely new forest land which is almost void of humus and available nitrogen. This speaks well for the cultures. (Alfalfa.)

Charlottetown, P.E.I. The boundary between the two plots is distinctly marked, that growing from the inoculated seed is a richer green and of stronger growth. (Alfalfa.)

Brule, N.S. The difference between treated and untreated plants was more marked after the first cutting. The treated are now about one foot high and of a dark green healthy color. The untreated are only a few inches high and except in a few scattered bunches are yellow and sickly. (Alfalfa.)

Marshville, Ont. I sowed two acres last spring without nitro-culture and the roots are smaller than what I sowed this spring with treated seed. (Alfalfa.)

St. Catharines, Ont. The culture was used on alfalfa sown in April on fall wheat about 15 pounds per acre. The stand at present is considered good, a difference being evident in favor of the nitro-culture treated seed. (Alfalfa.)

Treesbank, Man. Nodules are plentiful on the part sowed with the treated seed, but I have not been able to find any on the other strip seeded

with untreated seed. Furthermore, the second growth on the untreated strip is now sickly looking and much shorter than the rest. (Alfalfa.)

In addition to these reports, special mention may be made of the results obtained by Principal Cumming, of the Nova Scotia Agricultural College, Mr. F. T. Shutt, Chemist, Central Experimental Farm, Ottawa, and Mr. C. Jarvis, Assistant in Horticulture, Cornell University Experi-



Peas grown in swamp soil. The roots on plant marked "O" had no nodules. Peas planted in the other two pots marked "Culture" and "Lime and Culture" were treated with nitro-culture. The pot with lime was treated at the rate of 1,000 pounds of lime to the acre. The roots of these two plants had numerous nodules.

ment Station, as these gentlemen are accustomed to carrying out experimental work.

Principal Cumming writes as follows :—

“ The only positive results we have to report are with your alfalfa culture. Our red clover was sown just in time to catch the drought, and neither that treated with culture or left untreated amounted to much.

“ The peas and vetches all grew very rank, and it was impossible to notice any difference between the treated and untreated plots. With the alfalfa we were more successtul, having sown it just at the right time. We conducted the experiment in duplicate, and had side by side plots that were untreated with culture, plots treated with United States Department of Agriculture culture, and plots treated with your culture. For some reason or other, we got no decided results with United States culture; possibly it was not rightly handled. Of this I am not sure, for I was away from home when the seed was treated. The most marked results were found on a piece of land, which was seeded with a nurse crop of barley. The plot that was treated with your culture has, at the present time, a most vigorous growth of alfalfa, the plants being on an average of eight inches high, which, considering the dry season, is very good. On the untreated plot adjoining the alfalfa will not average more than one inch in height, and the plants are rather sickly looking.

“ I sent you by last night's mail a representative plant from each plot, and you will readily observe the decided difference in the nodular growth. I have sent a picture of the two plots to the “ Farmer's Advocate ” asking them to make plates.

“ Our most striking results are on a piece of land which was in roots last year, and consequently was free from weeds of all kinds when the alfalfa was sown. We tried a duplicate experiment on a piece of land, which was ploughed out of sod after having been down fifteen or twenty years. We grew six plots on this piece of land ; two untreated, which amounted to almost nothing ; two treated with United States culture, which are little, if any better, and two treated with your culture, which are so strikingly superior that you can pick out the plot almost as far away as you can see.

“ In the light of these results we are very anxious to continue our work and would like especially to treat red clover seed as successfully as we seem to have treated alfalfa.”

The results obtained at the Dominion Experimental Farm were as follows :—

Pot Experiments. Clover, sown May 6th., 3 cuttings.

Total weight of green crops from untreated seed . . . 374.7 grams.

“ “ inoculated seed . . . 450.7 “

“ “ inoculated soil . . . 440.4 “

A difference of about 17 per cent. and 15 per cent. respectively in favor of inoculated

Pot Experiments. Alfalfa, sown May 6th., 3 cuttings.

Total weight of green crop from untreated seed . . .	204.5	grams.
“ “ inoculated seed . . .	217.3	“
“ “ inoculated soil . . .	249.1	“



Soy Bean Plant. The one on the left is from untreated seed, that on the right from seed treated with nitro-culture.

A difference of about 6 per cent. and 18 per cent. respectively in favor of inoculation.

Plot Experiments. Clover sown May 9th. Each plot 22 by 33 feet.

	lbs.	ozs.
Hay crop from untreated seed (2 cuttings).....	46	11
“ “ “ inoculated seed (2 cuttings).....	59	13

A difference of a little more than 22 per cent. in favor of inoculated seed.

Plot Experiments. Alfalfa, Sown May 9th. Each plot 22 by 33 feet.

	lbs.	ozs.
Hay crop from untreated seed (3 cuttings).....	88	4
“ “ “ treated seed (3 cuttings).....	62	13

A difference of nearly 30 per cent. in favor of the untreated seed.

Mr. Shutt makes no explanation of this difference in favor of the untreated seed, but writes :

“The nodules on the roots of the untreated alfalfa appeared to be just as numerous as on the roots of the inoculated.

“The soil is a light, sandy loam, fairly rich in humus. It has in all probability carried legumes, but not for some years.”

Mr. C. Jarvis, of the Department of Horticulture, Cornell University, tried the culture on the Mohawk variety of bean. Each row was 20 feet long. His results are as follows :—

“1. Mohawk Beans untreated—30 plants, no nodules.

“2. Beans treated with fresh culture and sown at once—27 plants, 12 with nodules.

“3. Beans seeded two weeks later but treated same time as in Experiment 2.—35 plants, 2 with nodules.

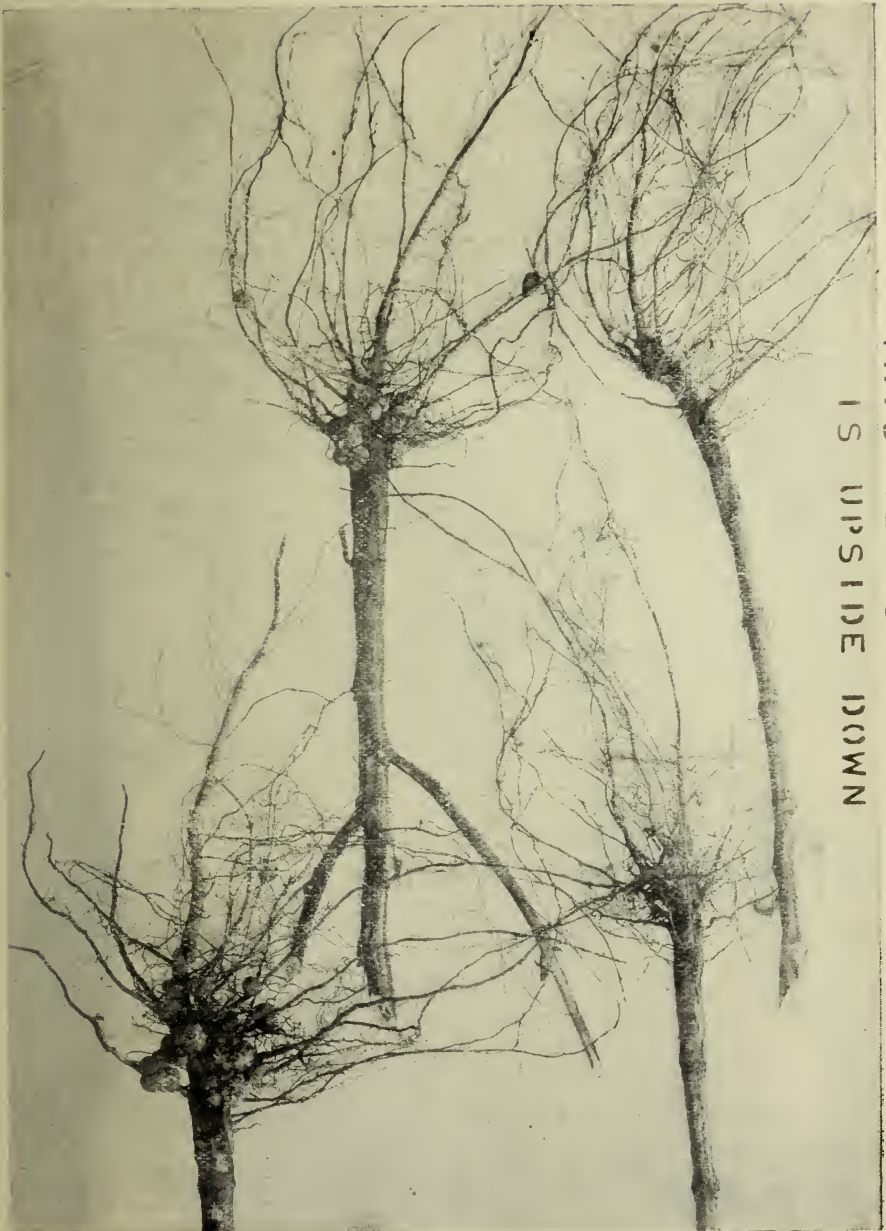
“4. Beans untreated sown at same time as in Row 3—37 plants, 7 with nodules.

“5. Beans treated with culture 1 month old and sown in a moist condition—31 plants, 6 with nodules.

“6. Beans untreated sown at same time as No. 5—35 plants, 3 with nodules.”

As will be seen from above the best results were obtained from fresh culture used according to directions; the remaining experiments were conducted on Mr. Jarvis' own initiative. Mr. Jarvis remarks: “Had some other variety of bean been used in place of Mohawk, which is a very hardy, strong growing variety, a difference in *growth* may have been apparent.”

As the Bacteriological Department intends to continue experimental work along this line, and will send out nitro-cultures in the spring of 1906, some information is needed regarding the use of the cultures and their application; hence a few notes are given for the guidance of those who desire to experiment with these beneficial bacteria.



THIS ILLUSTRATION
IS UPSIDE DOWN

Roots of Soy Bean. Those on the left are from untreated seed, while those on the right are from seed treated with nitro-culture. Note the nodules on the roots.

It should be thoroughly understood that these nitro-cultures are of use for legumes only, such as the clovers, beans, peas, and vetches, or, as they are sometimes termed, the pod-bearing plants. We have had a number of applications for nitro-culture for inoculating wheat, turnips, etc., but these bacteria are of no use whatever for such crops.

1901 Inoculation—and by inoculation we mean the treatment of the soil or seed with the nodule forming bacteria—is necessary when the land has never before been seeded down to a leguminous crop, or if legumes have grown in it without forming the characteristic nodules or tubercles, which is proof that the nodule bacteria for that particular crop are not present in the soil. In such cases as these the farmer may well resort to inoculation.

Inoculation is also desirable if a farmer wishes to grow a new kind of legume on land even though it has previously grown excellent crops of a different species of legume. Thus, although red clover may have been successfully grown, with a large number of nodules on the roots, the bacteria from these nodules may not infect alfalfa or lucerne if it were planted in the clover soil, and hence, inoculation with bacteria taken from the alfalfa nodules, would be desirable. So also, when introducing the culture of vetches, of field beans, and soy beans, it would be necessary to treat the seed with bacteria taken from these plants. In some cases, bacteria derived from closely related species are mutually available, thus bacteria from sweet clover (*Melilotus*) are capable of infecting alfalfa. It seems especially desirable in Ontario to inoculate the field bean and soy bean, as experiments have shown that Ontario soils are not so generally infected with the bacteria appropriate for these plants as for the other legumes, and there is less possibility of their becoming inoculated from the bacteria of closely related wild legumes, on account of the relative scarcity of the latter plants.

The employment of nitro-cultures is recommended also on soils which produce a weak growth of legumes even when nodules are present, the more vigorous bacteria of the culture aiding the plant to fix more nitrogen and in those cases where the leguminous crop is not producing the highest yield.

A word of warning is necessary with regard to failures in the use of these nitro-cultures, and also with regard to their use as a remedy for lack of care in preparation and cultivation of the soil. No benefit may be expected from the use of nitro-cultures if they are improperly prepared, the directions for their use are clearly set forth, and should be strictly followed. The farmer simply invites failure, if, for example, as some have done, he disregards the directions and uses the culture on turnip seed, instead of for the legume for which the culture was prepared.

Failure of plants to form nodules, even when the seed is inoculated, may result if:

1. The soil is too acid or too alkaline. Lime should be first applied if the soil is too acid.
2. If some fertilizer with a caustic action is brought into contact with the treated seed.

Little benefit may result from inoculation :

1. If the soil does not contain sufficient of the other necessary plant foods, especially potash and phosphoric acid.
- 2. If the soil is too rich in nitrogen; in this case it is better to plant crops that are nitrogen feeders rather than nitrogen accumulators.
3. If the soil is not properly cultivated and freed from weeds.
4. If the soil is already thoroughly inoculated with the nitrogen-fixing bacteria.

METHODS OF INOCULATING.

There are three methods of inoculating the crop :—

1. By transfer of soil. 2. By treating the soil. 3. By treating the seed.

In the first case, soil which is known to contain the nodule-producing organisms is scattered over the land where it is desired to grow a crop of legumes. In other words, the land is top-dressed with soil from an infected field. This method has given good results, but is expensive when the soil has to be brought any distance, and in certain sections of the country such a practice is fraught with danger, as weed seeds and certain diseases are apt to be transferred from one field to another by this means.

In the second method, a quantity of soil is moistened with large quantities of culture, and this is mixed with more dry soil, and then used as a top dressing on the land that is to be planted. We have not tried this method of soil inoculation, and it is not convenient for our method of culture distribution. For small gardens, liquid cultures may be used and applied by means of a watering can to the young plants, but it is far better to have the bacteria on the seed so that the plant may become inoculated when they commence to grow.

The third method, seed treatment, consists in moistening the seed with a culture or growth of the desirable bacteria, allowing the seed to dry for a *short* time and immediately sowing it. We recommend that cultures supplied by us be used for seed inoculation.

DIRECTIONS FOR THE USE OF NITRO-CULTURES SUPPLIED BY THE BACTERIOLOGICAL DEPARTMENT OF THE ONTARIO AGRICULTURAL COLLEGE.

The culture is sent you with the understanding that it is to be used for experimental purposes and that you will use it as directed and report to us your success or failure.

1. For every 60 pounds of seed to be treated take one and one-half pints of clean cool water in a small pail.
2. Pour some of the water into the bottle, shake the bottle and pour back the water into the pail. Repeat this until the culture is all rinsed from the bottle into the pail and the water in the pail is clouded. The jelly-like substance in the bottle is agar, it will not dissolve, but may be broken up and stirred in the water.

3. Pour the water from the pail over the seed and mix thoroughly.
 4. Spread out the seed to dry in a clean place out of the sunshine.
 5. The seed will dry in an hour and may be planted in the usual manner as soon as it is dry.
 6. Do not add water to the culture in the bottle until you are ready to plant your seed.
 7. Some untreated seed should be planted for comparison and it is well to plant this first.
 8. After the seedlings are one month old, look for nodules on the roots. During the season note number and size of nodules and vigor of plant growth from treated and untreated seed.
-

ANNOUNCEMENT.

For the spring of 1906 the Bacteriological Department is preparing to send out a *limited* number of cultures for the inoculation of the following legumes : Red Clover, Alsike Clover, Alfalfa or Lucerne, Field Peas, Vetches, Field Beans and Soy Beans, Those desiring cultures will please make application according to the following blank form.

APPLICATION FOR NITRO-CULTURE.

I should like to conduct an experiment with Nitro-culture for Red Clover, Alfalfa or Lucerne, Vetches, Soy Beans, Alsike Clover, Field Peas, Field Beans.

(Strike out those *not* wanted).

State probable date of seeding.

If the material is sent to me I shall endeavor—

1. Carry on the test according to the instructions received.
2. Exercise care and accuracy in the work.
3. Report the results of the experiment as soon as possible after harvest, whether successful or not.

Name

Post Office..... Express Office.....

County Province

This sheet when filled out should be addressed to the Bacteriological Department, Agricultural College, Guelph, Ontario, and will require 2 cents postage whether the envelope is sealed or not.

Ontario Department of Agriculture.

LIVE STOCK AND FARMERS' INSTITUTES BRANCHES.

The Swine Industry in Ontario.

INTRODUCTION.

The information regarding the condition of the swine industry in the various counties throughout the Province, and the general feeling of the producers and feeders towards the industry, have been obtained from the replies to a number of questions contained in a circular sent to correspondents by the Bureau of Industries.

The object of procuring and compiling this information is to place everyone interested in a position to obtain a more intimate knowledge regarding the hog production of the Province, with special reference to the present conditions affecting production. Each person should thus be able to decide more intelligently as to what his policy should be with reference to the production and feeding of hogs at the present time.

Following is the list of questions referred to:—

(1) What breeds, grades or crosses of hogs appear to be most popular in your district?

(2) Has there been any general tendency to change from one breed or type of hog to another during the last two or three years?

(3) If there has been any change in the kind of hogs fed, please describe the nature of the change.

(4) Are grade sires used in your district?

(5) What is the general feeling among farmers in your section as to the hog production this year? Do they show a disposition to increase their output and to what extent?

(6) About how many breeding sows were kept by the average farmer of your section in 1904? How many in 1905? How many this season?

(7) What is the average number of pigs to reach weaning age in spring litters this year? Has the percentage of loss been greater than usual.

(8) How will the delivery of hogs between now and September 1st compare with that of 1904 and 1905?

(9) What do you consider the average cost of production of bacon hogs fitted for market? (a) Summer feeding; (b) Winter feeding.

With reference to question 1, a large number of correspondents replied to it by giving the name of breed or breeds most popular in their district. While, in the particulars regarding each county, credit is given to these breeds it must undoubtedly be read to include not only the pure-breds of the breed mentioned, but also the grades of that breed. It should also be noted that in reply to this question some correspondents

answered the question as asked, giving the most popular breed and perhaps the breed found next in favor, while there is no doubt there are other breeds or grades of other breeds found in that locality, small in numbers compared with the breeds mentioned, but given no standing at all in the report. Other reports gave particulars as to all breeds found in the district. Taking the reports as a whole, therefore, while the statements as to the popularity of the breeds will be correct, it is almost certain that the breeds least mentioned will be found to some extent more plentiful throughout the Province than the summary for each county would indicate without the above statement being borne in mind.

Question 4 was answered in a great many cases by either "Yes" or "No." In the former case it was understood to mean that grade sires were used in that section, but not necessarily to any considerable extent; and that grade sires were not used in any large numbers in any district, unless the fact was specially stated in the reply to this question.

In reply to question 8, a great many correspondents made no distinction between 1904 and 1905, and in these cases the comparison was taken to be with 1905.

The reports of the counties are arranged so that as far as possible the reports of sections having somewhat similar conditions may be read together. The index on page 36 gives an alphabetical list of counties, the number of pigs sold or slaughtered in each county during the year ending June 30, 1905, as compiled by the Bureau of Industries, with the page on which the report of each county may be found.

ESSEX.

The breeds of hogs as named here are in order according to their popularity with the farmers in this county:—Berkshire, Chester White, Duroc Jersey, Poland China, Yorkshire and Tamworth. The corn-fed fat hog seems to be the kind generally produced. Little tendency to change is noted unless it be in places where bacon hogs are being tried and persons using them wish to go back to the fat pig which brings them as much money with less care in feeding. Most of the returns would indicate that little attention is given to breeding. In some sections of the county most of the sires used are grades, and more than seventy-five per cent. of the correspondents report the use of some grade boars.

The desire is to increase production to some extent. In 1904 the average number of sows kept was 3.4; in 1905, 3.5, and this year 4. Litters are comparatively small, averaging only 6.6, and losses are but slightly more than usual. Summer deliveries will likely be light, as many farmers have already sold all their pigs weighing over 100 pounds. Feed is scarce in some cases, which will cause delay in finishing pigs.

According to the figures given by correspondents the cost of feeding hogs is very high. The average cost of producing 100 pounds in summer is \$5.25, and in winter \$6.33.

KENT.

In this county we find a mixture of a great many breeds, and a number of the correspondents state that while there is a tendency on the part of a few of the breeders to use sires of the bacon breeds, the larger proportion of the producers are using Berkshire, Duroc Jersey and Chester White sires, although we find Yorkshires and Tamworth sows or crosses of them in as large numbers as of the other breeds named.

Quotations from a few correspondents will indicate the situation:—

“There is a tendency to breed a thick fat hog. The only way to get a bacon hog is to discriminate. The dollar is the best educator I know of. As long as the farmer can get the same price for the thick hog he is likely to raise the hog he can feed the easiest.”

“There is a tendency to change from Yorkshire and Tamworth to Berkshire, Chester White and Duroc Jersey. Better feeders and better results from the same amount of feed.”

“Farmers who have kept two or more sows and had pigs littered at the same time and always fed together find the Yorkshires harder feeders and fully a month later before they are ready for the market, compared with Berkshires and Chesters. The Tamworth-Berkshire cross is considered a good pig and a good feeder. A breeder here who keeps and breeds Berkshires, Yorkshires, and Tamworths, stoutly maintains that the Yorkshire is by far the poorest hog. He has fed and bred all three sorts for years under the same conditions.”

“In some quarters, preference is given the long bodied hogs in preference to the short and thick type, but most people are satisfied with fast growing hogs of any type.”

There are probably as many grade sires kept in this county as in any other, but there is a tendency recently to use a greater number of pure-bred sires. These sires are for the most part of the Berkshire, Chester White and Duroc Jersey strains. In selecting these sires, there is a tendency to choose those that more nearly approach the bacon conformation.

There is a great variation in the statements as to the number of breeding sows kept. There is a tendency on the part of the majority of producers to increase their output, but on account of high prices and the scarcity of hogs, and in some sections a fear that the hog cholera may again break out, the production is considerably below what it otherwise would be. The outlook for 1907, however, is very bright for a largely increased output.

The hogs to be marketed before September will be considerably less in the greater portion of the county, while in a few localities the delivery will be larger than in the past two years. The average number of pigs per litter is 7.22, and the loss among young pigs is not greater than in former years.

While the correspondents are unable to give definite figures to substantiate their statements, it is claimed by some that the Berkshires and Duroc Jerseys can be fattened more cheaply than Tamworths or Yorkshires, even one cent per pound less. The cost of summer production is estimated at from as low as three cents to as much as six cents per pound, while winter feeding is placed all the way from four cents to seven cents per pound. The summer average being \$4.49 and the winter average \$5.41.

ELGIN.

While Yorkshires, Tamworths and Berkshires have been produced largely and in relative numbers in the order named, there is a tendency to cross the first two named with the Berkshires. Considerable Chester White and some Poland China blood has been introduced. While pure bred sires are generally used there is a tendency on the part of a few producers to give little consideration to the breeding or quality of the sire. Many of the farmers are paying close attention to the individuality of the stock used for breeding purposes, and are selecting the hogs approaching the bacon type, no matter what the breed may be.

The attitude of some of the producers is well shown in the following extracts: "Yes, changes are going on all the time, as some think that some other breed is better than what they have, and then they change for another kind." "About three or four years ago there was great talk of bacon hogs and people went to extremes, crossing Yorkshires and Tamworths—a result, poor feeders and slow maturers." "While there is a tendency to increase the output on the part of many of the producers and the delivery will likely be somewhat larger than last year, a number of the farmers have lost confidence in the stability of the market and are making no effort to increase their output, or even to keep up to the record of the past few years." "There is always a tendency to increase any kind of stock when prices are high, but in hogs we always look for a big drop in prices in the fall."

The average number of breeding sows kept by each farmer is two and a half, somewhat more than in 1905 and less than in 1904. Greater numbers would be kept were it not for the very high prices and the scarcity of supply. The number of pigs per litter to reach weaning age is given as from 5 to 10, with an average of $7\frac{1}{3}$, the smallness of the number being due largely to the greater than usual mortality during the first few weeks. The loss is much greater in the early spring litters.

While a few of the correspondents state that the delivery before September 1st will be somewhat larger than in 1904 or 1905, the greater number consider that the output will be considerably less, while a limited number estimate it at about the same.

None of the correspondents are able to give a statement of the exact cost of production, and the estimates vary from \$3.50 to \$5.50

for summer feeding, and from \$4.25 to \$7.75 for winter feeding. The average being \$4.43 for the summer and \$5.34 for winter production.

NORFOLK.

Berkshires and Yorkshires are about equally in favor with farmers here. The Tamworth is also quite popular and there are some Chester Whites. Crossing of the Yorkshire or Tamworth with the Berkshire is largely practised. It is said that there was a time when people would be continually changing from one breed to another, but each farmer is now making his choice and trying to stick to it, much to his own advantage. Several expressions of disappointment are noted from those who after they have raised the best type of bacon hogs have failed to secure any better price than their neighbors who marketed hogs unsuitable for the bacon trade. Grade sires are still used in considerable numbers. The high price prevailing for hogs is stimulating more activity in breeding with promise of a largely increased output within the next year if no marked decline in prices takes place. Each farmer kept on an average 2.05 sows in 1904; 1.87 in 1905, and has 2.15 this year. Bad luck was experienced with some litters during the cold weather of March, but as a rule litters are somewhat larger than usual, the number at weaning time being 7.8. Marketing of hogs during the summer will be about as last year.

Discussing the cost of feeding a correspondent says: "It depends largely upon the feed used. Clover and rape along with plenty of whey and milk help wonderfully, as do mangels, turnips, and sugar beets in the winter. The finishing should always be with a grain ration." The estimated cost of summer feeding is \$4.60 per hundred; winter feeding, \$5.40.

HALDIMAND.

Although Yorkshires are by far the leading breed, there is a strong tendency to introduce more Berkshire blood, in hopes of securing easier feeding, earlier maturing hogs. Tamworths and Chester Whites are bred to some extent. About half the correspondents have noticed the use of grade sires in their localities and a large proportion of the sows are grades.

Individual feeders will endeavor to raise more pigs than usual this year, but the movement is not general. Uncertainty regarding future prices for marketable hogs, and the present high prices of grain tend to retard breeding operations. One writer says: "If buyers would pay a more regular price it would be better for all." Another says: "The feeling of farmers is that there will be a shortage of hogs, but they do not care to increase the output on account of grain being high priced and hogs are liable to be low when ready for market."

Farmers are keeping on an average 1.74 sows this year; in 1905 they had 1.6, and in 1904, 1.5, which shows that there is a gradual

increase in breeding stock. The average sow has brought through 8 pigs, which is about the usual number. Production of pigs fit for market before September 1st is expected to slightly exceed that of the last two years.

Cost of feeding in summer varies from \$2.50 to \$5 per hundred; in winter from \$4 to \$6. \$4.50 is the average for summer and \$5.21 for winter.

WELLAND.

The majority of hogs in this county are Berkshires or Yorkshires and crosses of the two. Some use Tamworths and a few farmers have Chester Whites. In districts from which hogs are shipped to the packing houses care is taken to produce a good type, and the Yorkshire is growing in favor. Where breeders are catering to the local markets only they raise shorter hogs and often sell them when they weigh from 100 to 140 pounds. But few grade sires are used.

There is very little tendency to increase production. Some farmers seem inclined to abandon hog raising because of the uncertainty of profits. The number of breeding sows to the farm is gradually decreasing, being 1.73 in 1904; 1.47 in 1905, and 1.42 in 1906. Litters are a little smaller than usual, the average number weaned this season is 7.6. Because of the smaller number of breeding sows, reduced litters and the number of hogs sold to supply the local markets at five or six months of age the output this summer will show a decrease.

Large quantities of refuse are used for feeding hogs, and pasturing in orchards is extensively practised, so the cost of feeding is lower than in some other counties. The average of estimates for summer feeding is \$4.38 per hundred and \$5.15 for winter. One correspondent says: "The bacon hog can be produced at a smaller cost than a great many imagine if they have good pasture (clover and peas) in summer and roots and other green food in winter.

LINCOLN.

The leading breeds in this county are Yorkshires, Berkshires, Chester Whites, and Tamworths. For crossing with the Yorkshire, the Berkshire and Chester White are largely used. When the Chester Whites are used the desire is to get white pigs without any particular consideration for bacon quality. The general tendency is to improve the breeding of the pigs to make them better able to meet the requirements of pork packers. Quite a number of grade sires are still being used throughout the county.

Where general farming is practised there will be some increase in the output, but a great many keep just sufficient hogs to eat the refuse from their fruit farms, and with these the numbers do not vary much from year to year. The average number of sows kept in 1904 and 1905 is 1.25 and in 1906, 1.5. The litters were very satisfactory, averaging 8.5 pigs each at weaning age, with losses a little less than usual.

There will be about the regular number of hogs for delivery between now and September. One farmer claims his hogs cost him very little as he feeds them nothing marketable except some milk. Others who buy grain find it hard to make a profit. The average cost for summer is \$4.16 and for winter \$5.05 per hundred pounds.

WENTWORTH.

Yorkshires are the most popular while Berkshires are looked upon with favor by some; the crosses of these breeds are fed extensively. There are also a few Tamworths. There appears to be slight tendency to any change; such as there is seems to be in favor of the Berkshire, the reason given being that it is thought to be an easier feeder. Practically no grade sires are used. There seems to be a disposition to slightly increase the production. One correspondent says: "The disposition is to increase the output, but owing to the fact that brood sows are scarce, very little change will take place before the latter part of the year."

The average farmer keeps about two sows, and there appears to be very little difference between 1904, 1905 and 1906. Compared with 1904, there was a slight decrease in 1905 and a slight increase in 1906. The size of the average litter is 7.45. Most of the correspondents believe that the loss in litters will not be more than is usually the case, while others consider that there is a greater loss. One correspondent states that while the loss has not been greater than usual, the litters are smaller. The almost general opinion is that the delivery of hogs between now and the 1st of September will be lighter than in 1904 and 1905, some estimates placing the shrinkage at 30 per cent.. One correspondent states that several of the largest growers in his section have gone out of the business to stay. Another correspondent states: "Coarse grains show a tendency to be pretty high, deliveries will likely be heavy for a few months and consequently make supplies scarcer later on."

The estimates as to the cost of feeding vary from $3\frac{1}{2}$ to 6 cents in summer, and from 5 to 8 cents in winter; the average is, summer feeding, $4\frac{1}{2}$ and winter feeding $5\frac{1}{2}$. Several feeders state the cost of feeding is no more in winter than in summer. Their estimate of cost in each case is 5 cents.

LAMBTON.

The Yorkshire is the leading breed of hogs in this county and continues to grow in popularity. Berkshires are quite common and are liked for crossing with Yorkshires; Tamworths are usually considered harder to feed than the other breeds, so their number is not increasing. The general tendency is to produce bacon hogs of a good packer's type. About half the correspondents make note of grade sires being used in their section. Gradual improvement, however, is being made in this respect.

Breeding sows last year numbered 1.22 per farm; in 1904, 1.47, and this year 1.35 on an average. Losses in litters have been considerably larger than usual. At weaning time the average number of pigs was 7.9. This would indicate less pigs to be marketed during the summer than in 1904, and probably about the same as last year. The general tendency is to breed more sows, so that a gradual increase in production may be looked for.

Estimates as to the cost of feeding vary from \$4 to \$5.50 for summer, and from \$4 to \$7 for winter feeding. In winter, feeding is usually considered to cost about \$1 a hundred more than in summer. The average cost is: summer, \$4.63; winter, \$5.64.

MIDDLESEX.

The breeds mostly used for breeding purposes, named in order of their popularity, are: Yorkshires, Berkshires, Tamworths and Chester Whites. Tamworths and Chester Whites appear to be decreasing, and their places are being taken by Berkshires and Yorkshires. Very few grade boars are referred to. Many pure-bred sows are used for crossing with males of other breeds, the claim being made that the cross-bred is an easier feeder than the pure-bred.

The views generally expressed by correspondents regarding the present condition of the hog industry are very well summed up by one writer, who says: "The farmers are all trying to get into hogs as fast as possible. A great many sold their sows eighteen months ago and are now sorry they did not keep them." The breeding sows now on hand are about the same as last year and less than in 1904, the number for this year being 1.6. The average size of litters at weaning is 8.3 pigs, and there have been about the usual losses in young ones.

Deliveries between now and September are going to be rather lighter than those usually made during the summer, but an improvement is to be looked for during the autumn. Should the good prices be maintained this county is likely to largely increase its production of hogs during the next year.

The figures given as the cost of producing hogs appear to be individual opinions rather than the results of actual experiments. With summer feeding the cost of one hundred pounds varies from \$3 to \$6, and with winter feeding from \$4 to \$9. The average of the figures given by all the correspondents are: summer feeding, \$4.57; winter feeding, \$5.54, per hundred pounds.

OXFORD.

The returns show that farmers are far from having one opinion as to the best breed of hogs. A few extracts will show how different some men's views are: "The tendency has been almost universal to eliminate all breeds except the Yorkshire. The type sought after is the bacon type as approved by the packers." "A few years ago Yorkshires were the proper thing, but the bulk of farmers think they have found out

that the Yorkshires are no better than some other breeds." "The Berkshires are taking the place of the Yorkshires and Tamworths." "I can get the best results from a Chester White sow crossed with a Berkshire boar." "Some of the neighbors tried Poland Chinas, but they did not give satisfaction." "In some cases a change has been made from the Yorkshires and Tamworths to Chester Whites and Berkshires, but in the majority of cases they have in a short time changed back. Farmers made the change from a false idea of economy, believing that Chester Whites and Berkshires could be made to weigh 200 pounds with less feed. Small litters and an excess of fat at an early age has more than counterbalanced this." The general opinion is strongly in favor of the Yorkshire. The Berkshire appears to be increasing at the expense of the Tamworths and the American breeds. A Yorkshire-Berkshire cross is growing more popular, but as a rule farmers are careful of the type, having a desire to produce good bacon hogs. Only two-fifths of the correspondents report the use of some grade sires in the districts. One says, "Farmers see that it does not pay to breed or feed hogs from scrubby dams bred to grade sires as they used to do."

Quite a strong tendency to increase production is noted. A writer says that farmers will do all in their power to supply the shortage caused by shutting out American hogs. Another believes that if the packers continue to make it worth the farmer's while, by sufficient remuneration, Ontario can and will produce the right article, and in sufficient quantity to keep the packing houses supplied continuously.

Brood sows now average 2.5 to each farm, whereas in 1905 there were 2.1, and in 1904, 2.2. sows each. Litters have been very good, averaging 8.1 pigs, and losses have been about normal. Hogs marketed between now and September 1st will be less than for the last two years; an increase may be looked for during the autumn, and if prices keep up there should be heavy increases in production during the next year.

Speaking of the cost of feeding hogs, one correspondent makes a frank admission. He says: "This is the average farmer's failing. I do not know." The average of what the cost is thought to be is: Per hundred pounds, \$4.58 in summer, \$5.28 in winter. Those who have not kept account of the cost should take particular notice of the following extract from one farmer's report: "We have as yet made no experiments to ascertain difference in winter and summer production. For the entire year of 1903 the cost of producing a pound of pork was 3.63 cents; for 1904, 3.49 cents." It will be noticed that these figures are much lower than what is usually thought to be the cost of production.

BRANT.

The most popular breeds of swine are the Yorkshire, Berkshire and Tamworth. The Yorkshire is the leading breed, while the Berkshire is popular in some sections for crossing with the other breeds. It

is generally claimed for such crosses that they have easier feeding qualities and are ready for market at an earlier age than the pure-bred pigs, although no facts are given to substantiate the claims. Very few farmers patronize grade sires and the majority of sows are well bred.

There is a strong tendency to increase the production of hogs, as one correspondent says: "It is the most profitable part of mixed farming to-day, therefore on the increase." One writer thinks the increase will amount to fully 25 per cent. From the facts given, however, it appears impossible that any such large increase as this can be made. Old sows are expensive, and are no more plentiful than in 1904, there being an average of 2.2 sows per farm for each of the years; this is .4 more than in 1905. Litters are only averaging 7.6 pigs each, which is less than usual. The high prices being paid by the packers are tempting some to market their young sows. Under these conditions it seems improbable there can be much increase in the supply of hogs for some time.

Figures given for the cost of feeding are generally a little lower in this county than from other parts of the Province. The average cost of summer feeding is estimated to be \$4.39, and winter feeding \$5.21, for each hundred pounds.

WELLINGTON.

By far the most popular breed in this county is the Yorkshire. The next is the Berkshire, while in quite a few sections there are a few Tamworths. The Yorkshire-Berkshire cross is very popular, while in a few sections the Yorkshire-Tamworth cross is used. In a large proportion of the sections there is no inclination to change from the type of hog grown. In most of the sections where a change is noted, however, there is a tendency to go more to Yorkshires. In two or three sections there is an inclination to go to a slightly shorter and fatter hog. One correspondent reports the extreme type of bacon hog is going out. Another one says: "Farmers are not paying much attention to type as they all go at the same price." Another report states: "There is a decided inclination to grow shorter and thicker pigs." Another says: "There is a slight tendency to change to the shorter, fatter breeds, as buyers do not discriminate."

Pure-bred sires are used almost entirely. In a small number of sections grade sires are used to a very limited extent. There appears to be a slight tendency to increase in a number of sections; the greatest number of districts, however, report that there is no disposition to increase the output. One correspondent reports: "Farmers seem well satisfied with the hog business; everyone seems anxious to increase, but no special attempt to jump into larger herds of swine." Another correspondent reports: "There is no disposition to increase the output, as we consider the market subject to sudden changes." Another report says: "There is a general feeling to take advantage of the present good prices, but no excitement to go into the business very strongly for fear prices drop. The price is so uncertain that they are not buying sows

to breed, but are caring well for the ones they have." Another report says: "No large increase in numbers, but a tendency to better feeding and to make the finished product heavier." Still another report: "A great many would increase if they thought present prices would continue, but some were disappointed in that respect in the past."

In 1906 the number of sows has slightly increased over the number for 1905, but is less than the number for 1904. The average litter is 7.5. Taking the county as a whole there appears to be a greater percentage of loss in young pigs than is usually the case. It is expected that the shipments before September 1st will be lighter than in 1905. One correspondent states: "The delivery will be light the first months and heavier for September." Another correspondent states: "So far as this district is concerned the hogs are being marketed in a very immature state, probably on account of very high prices, or perhaps shortage of feed."

The price for summer feeding ranges from $3\frac{1}{2}$ to 6 cents per lb., and for winter from $4\frac{1}{4}$ to $7\frac{1}{2}$ cents per lb. The average for summer feeding is \$4.70 per cwt., and for winter feeding \$5.45 per cwt.

WATERLOO.

Public opinion is strongly in favor of Yorkshires as the most desirable breed. Berkshires appear to be about 50 per cent. less numerous and Tamworths 75 per cent. less. The number of Tamworths is inclined to decrease, while Berkshires are being used more largely for crossing with the Yorkshires. A few reports mention some farmers who are inclined to raise a fatter hog, but the majority have faith in the bacon type. There is room for considerable improvement in many of the sires used; reference is made to the use of grade sires in nearly half of the reports.

There is strong disposition to increase the number of hogs to as many as the farmers have feed for. Estimates of the increase to be looked for go as high as 60 per cent. It is not likely the increase will have much effect on the market for some time, as there is not sufficient breeding stock to meet the demands upon it. Sows and young pigs are selling at high prices. The average for the last three years of sows kept is: 1904, 2.3; 1905, 2.3; 1906, 2.6 per farm.

Litters have not been doing so well as usual unless where comfortable quarters were used for the pigs. The number of pigs weaned from each litter is 7.8. There will likely be a normal number of hogs marketed during the summer, and increases may be looked for later in the season.

The cost of summer feeding is averaged at \$4.69 per hundred, and winter feeding, \$5.28. Estimates vary from \$3.24 to \$6.00 in summer, and \$4.00 to \$7.00 in winter.

PERTH.

The breed used most extensively is the Yorkshire, Berkshire next, and then Tamworth. There are a few Chester Whites and a very few Suffolks. There seems to be a tendency to use more Berkshires, either as a cross or pure-bred, and a slight tendency towards Chester Whites. Tamworths do not seem to be so popular as they were, although they are used to quite an extent in crossing. The most popular cross is between the Berkshires and Yorkshires. One correspondent states: "There is a slight tendency with some to cross the Yorkshire with the bacon type of Berkshire, the object being to get a hog of a fair bacon type which will feed more easily." Another correspondent states: "The weight was 160 to 180 pounds; the tendency now is to get them over 200, to 250 pounds." Another report is: "Farmers are not so particular about marketing the typical bacon hog, as they get just as good prices for the thick fat." Another correspondent states: "There is a tendency to change from the long, straight, deep-sided hog to what is known as the more easily fatted hog." Still another correspondent says: "Farmers now are breeding the bacon hog for the demand of the packers, and they seem to be well satisfied."

In almost all sections pure-bred sires are used. In some sections, however, grade sires are used, but to a very limited extent. In some localities there appears to be a tendency to increase the output, but in most sections considerable caution appears to be used and the tendency to increase is very slight. One correspondent says: "Farmers seem rather dubious about increasing the output very much; they feel that once the output is sufficiently large to satisfy all packing houses, the price will certainly go down. They are not going into it in a wholesale way as some farmers did a few years ago."

There is an increase in the number of sows kept this year over the number in 1905, but they are still considerably less than in 1904. The average litter is 7.9. The loss will not run any greater than usual. The delivery up to the 1st of September will be less than 1905. Some districts report an increase, but taking the county as a whole, the shipments will be less.

The average of the estimates of cost for summer feeding is about \$4.54 per cwt., and for winter feeding about \$5.09. The estimates for summer feeding range from $2\frac{1}{2}$ to 6 cents per lb., and for winter feeding from $3\frac{1}{2}$ to 8 cents.

HURON.

The question as to the popularity of the different breeds of hogs is very well answered by a correspondent who says: "The Yorkshire is decidedly the leading breed at present; crosses of the Yorkshire and Berkshire, and Yorkshire and Tamworth are, however, valued by some. Pure-bred hogs of the above breeds and crosses have superseded the old mongrel breeds so prevalent in days of yore. The change of late

years has been from hogs of which the Poland China may be considered the type (too much fat and too little lean meat) to the Yorkshire suitable for the English trade." The Berkshire is being used rather more for crossing than formerly, and the Tamworth less. One correspondent's explanation of this is: "The sole reason of the change is the refusal on the part of drovers to pay according to quality; most people think short, thick hogs can be grown more cheaply than bacon hogs." Very few grade sires are used, and in many cases sows are also pure-bred, although they may not be registered.

Owing to the high price of grain many people do not consider the hog business very profitable at the present time and are not inclined to increase their production. Others, who have the grain, are feeding as many as possible. Big increases may be looked for within the next year if hogs continue to sell at good prices. An average of about 1.6 sows have been kept on each farm during the last three years. Litters average 7.3 pigs, with losses slightly greater than usual. Some reasons given for the increased losses are poor pens, pens with cement floors, and the feeding of too much barley. There will likely be quite a falling-off in the number of hogs to be marketed before September 1st.

The average cost of summer feeding is \$4.75, and winter feeding \$5.18. Those who quote the most economical gains grow their pigs on clover pasture in summer and roots in winter. The quantity of grain is increased towards the finishing period. There is a hope to soon be able to grow peas again for hog food.

BRUCE.

The breeding of the hogs appears to be confined largely to the Yorkshires and their crosses with the Berkshires and Tamworths. It is said that at shipping stations most of the hogs show strongly their Yorkshire blood and are of good bacon type. There is not much disposition to breed anything but hogs of the desirable type for the export trade. The percentage of sires not pure-bred is very small.

While farmers consider present prices all that could be desired, yet there is no great rush to go into hog raising. Still the general feeling is hopeful, young pigs and brood sows are selling at high prices, but as one correspondent states: "It takes considerable time to increase your output after you take the notion." Many farmers appear to look on hog raising with suspicion, and are ready to quit as soon as there is a drop in the price. The steadiness of the market will largely determine the amount of increase in production during the next year. There seems to have been no increase during the last three years in the number of sows kept. They average about 1.6 sows to each farm. At weaning time the average is 7.6 pigs to the litter. Losses of young pigs have been large. Returns indicate a smaller number of hogs to be marketed this summer than during the same season in 1905 and 1904.

The estimates of cost of producing bacon hogs in summer average \$4.66, in winter \$5.30, per hundred pounds. The result of an experiment conducted by a correspondent may be of interest. He says: "I had eleven pigs last year and kept an accurate account of what they cost me. I fed them three bags of shorts and 47 bags of mixed grain (barley, oats and peas, ground). I consider the mixture worth \$1 per bag, or \$50 for the grain. To this add \$1 for service of hog and \$5 for feed of mother, and the total cost is \$56. I sold at six cents, and received \$132.00. There is no allowance made here for skim milk or labor, as I could not make anything else out of the milk and the labor did not amount to much, the pigs being a summer batch. The pigs were six months and a week old, so I had a profit of \$76."

GREY.

Returns would indicate that about 50 per cent. of the hogs are of Yorkshire breeding, 25 per cent. Berkshire, 20 per cent. Tamworth, and 5 per cent. other breeding, mostly Chester Whites. The bacon type is generally kept in view in breeding, and improvement is gradually being made. In some cases where extreme length was formerly sought after farmers are getting a shorter pig. A few farmers have become careless, because drovers will not pay them a premium on selects. Boars are usually registered.

Farmers, as a rule, will be quite satisfied if they can keep up with the production of hogs of former years. For several years past a great many have been keeping as many pigs as they can handle. Where there is a tendency to increase the output, the fear of overproduction and consequent low prices induces caution. Many improvements are being made in buildings for hogs, and larger numbers will in future be fed during the winter. Nearly every farmer keeps a brood sow and raises his own pigs. One correspondent says: "There is more money in the business when a farmer raises his own pigs and grows his own feed." For each farm the number of brood sows kept has averaged about $1\frac{1}{2}$ for each of the last three years. Considerable increase in losses of young pigs occurred during the last season, still the litters at weaning time have been a very good size, numbering about eight pigs each.

Summer deliveries will probably be slightly below the last two years, the reason being that high prices have tempted feeders to sell light weight hogs during the spring.

In making a reply to the question regarding the cost of producing bacon hogs, one writer says: "I have to say that I really do not know. I do not think there is one in this locality who follows any systematic course of weighing or measuring the feed. We simply go it blind." The various estimates given average \$4.70 for summer feeding, and \$5.24 for winter feeding.

SIMCOE.

The most popular breed in this county is the Yorkshire. Berkshires and Tamworths are also found in quite large numbers; there are also a few Chester Whites. Crosses of these different breeds will be found in almost all sections. Some sections show an inclination to produce a slightly thicker pig than before, while in other sections they are working in the opposite direction. Taking the county as a whole there appears to be no tendency to change from the type of hogs now being produced.

In a great many sections grade sires are used. There appears to be quite a general belief that the tendency is to increase the production, some estimates going as high as 50 per cent. The following are quotations from different correspondents: "Farmers have been wild on hogs, and most of them have been stocking to a larger extent; some instead of keeping one brood sow are increasing to two, and in some cases more than two." "Farmers are a little conservative about increasing their bacon stock. While they are increasing their output, they are not rushing into it as they formerly did. They recognize that they can only grow a certain number of hogs at a profit." "Brood sows are scarce, farmers having sold so many in 1904, and they do not seem disposed to keep any sows that will bring them \$14 or \$15 from the drover, and run the risk of low prices in the near future." "The low prices of 1904 induced a great many to part with their brood sows; and last winter they were all anxious to replace them, and brood sows have been going at fabulous prices." "The general feeling is that there is no money in feeding hogs when the price is under \$6 a hundred."

There was considerable decrease in the number of breeding sows in 1905, and in 1906 there was a good increase over 1905, but still considerably below the number in 1904.

The size of the average litter is 7.22. There does not seem to be anything out of the ordinary in the percentage of loss of young pigs. It will probably be found, taking the county as a whole, that the delivery before September 1st will be a little better than in 1905, but considerably lighter delivery than in 1904. In some sections, however, the delivery will probably be lighter than in 1905. One correspondent states: "I have been a shipper of hogs for some time. In 1905 it was easier to get a double-deck than I can now get a single-deck; in fact, it is necessary now at times to ship half a carload." About 30 per cent. of the correspondents do not state the cost of feeding. In nearly every case where the cost is given they state it is simply an estimate; that no accurate figures are given. The cost of summer feeding varies from $3\frac{3}{4}$ cents to $5\frac{1}{2}$ cents; winter feeding from $4\frac{1}{2}$ to $6\frac{1}{2}$ cents. The average of the estimates for summer feeding is \$4.55 per cwt., and for winter feeding \$5.44 per cwt. One correspondent states: "I would sooner not raise any hogs except for my own use, unless I was pretty sure of getting \$5.50 per hundred for summer fed hogs, and \$6.00 per hundred

for winter fed hogs, at the price of coarse-grains for the last two years. Hired help is too scarce and wages too high to afford to raise many roots."

DUFFERIN.

A correspondent says: "There has been some experimenting with crossing, but all seem to lead to pure-bred Yorkshires as the most satisfactory hog." This view is strengthened by the other reports received; everyone mentions the Yorkshire, and 40 per cent. refer to the Tamworths and Berkshires, while 6 per cent. make note of Poland Chinas. There are some who advocate the use of the Berkshire for crossing purposes. A considerable number of grade sires are still being used, but farmers appear to be alive to the necessity of care in breeding.

Speaking of the prospects of production a correspondent writes: It is likely to keep about stationary until the trade gets into better shape; that is, when fewer middlemen are making a living out of the producers." Another says, "Quite a number have gone out of business this year on account of scarcity of feed." Considering the reports covering the whole county, it would appear that the marketable hogs before September 1st will be somewhat less than in 1904 and a little more than in 1905. The number of sows kept varies from two on each farm this year to a little less than two last year and rather more than two in 1904. Eight has been the average number in the litters, and losses have been greater than usual.

The average estimate for feeding gives the cost as about 50 cents per hundred pounds greater in winter than in summer. The figures are: summer, \$4.56, and winter \$5.09. Cheaper labor and the feeding of roots are mentioned as being helps toward keeping down the cost of winter feeding.

HALTON.

The pigs here appear to be nearly all of the Yorkshire or Berkshire breeds and their crosses and grades. In a few cases the Tamworths are raised. One correspondent states that the Yorkshires represent about 70 per cent. of all the pigs. Speaking of the kind of hogs being fed one writer says: "The only change has been an improvement with the object of getting a better type of bacon hogs." Another says: "Not much change, except a few Berkshire and Yorkshire crosses, they fatten easier." Less than 25 per cent. of the correspondents make reference to any grade sires in their locality.

The general feeling is that hogs are profitable, as high as fifty dollars has been paid for a brood sow this year. On an average $2\frac{1}{4}$ sows are kept on each farm. This is about the same as in 1904, and 20 per cent. better than 1905. The litters run about 8.2 pigs each, with losses somewhat less than usual, due to the mild winter, making it possible for the sows to get sufficient exercise.

Under ordinary conditions the number of pigs marketed during the summer should be about the same as in 1904, and a little less than in

1905, but there is a tendency to rush feeding faster than usual to avoid the drop in price that often occurs the latter part of September. This may mean that deliveries will be quite heavy between August 15th and September 15th.

Regarding the cost of production, one correspondent says: "Not many farmers take the trouble to figure out the cost accurately, but all are agreed there is no profit when the price drops below five cents per pound." The sum of the opinions expressed gives \$4.54 as the summer cost, and \$5.44 in winter, for each one hundred pounds. The estimates go as low as \$3.50 in summer and up to \$7 in winter.

PEEL.

One correspondent says: "Some think the Yorkshires are slow to mature and hard to fatten, and are changing to the Berkshire. The cross between the Berkshire and Yorkshire is being tried lately; they mature quicker and will sell at six or seven months, whereas the Yorkshire takes seven or eight months, and you get the same price for the cross as you do for the pure-bred." Although a few Tamworths are kept the Yorkshires are largely in the majority, with Berkshires a fair second.

A number of grade sires are in service, and one person remarks of his locality, that although "No grade sires are used some poor specimens of pure-breds are." There is considerable anxiety about the prices packers will give later on. Some are going to increase their breeding herds and others would like to could they be assured of the continuation of the present profitable prices. Mention is made of hogs being sent to Toronto market weighing 100 pounds or less when dressed. There is some improvement evident in the number of sows kept; in 1904 the average was about 2; 1905, a little less than 2, and in 1906 over $2\frac{1}{4}$ sows per farm. The pigs in each litter average about $7\frac{3}{4}$. Most reports show losses very much the same as last year. In some cases where there are many young sows the losses have been heavier. Deliveries between now and September 1st will be less than usual.

The average cost of summer feeding is \$4.74, and \$5.43 the cost of winter feeding. Emphasis is laid upon the cost of grain and labor as factors influencing the cost of production.

YORK.

The claim that the Berkshires are easier feeders than other breeds shows its effects in some sections, and this breed is quite commonly used. One writer says: "Most farmers have procured Berkshire sows which are easily kept, good breeders, quiet and gentle with their litters, and while crossed with Tamworths still produce a good bacon pig." This does not apply to the whole county, for the Yorkshire has a strong hold and seems to be more numerous than all other breeds together. A few Chester Whites and Tamworths are found in some localities. The majority of farmers are anxious to raise pigs suitable for the bacon

trade, and breeding operations are usually carried on with this object in view. In some places quite a number of grade sires are used, while in others there are very few or none.

There will be no general increase in production, as the breeding sows are not available. They are scarce and very high in price, so there will be little improvement until the young sows can be made use of. A few more breeding sows are being kept now than during the two years just past. In 1906 the average will be about $2\frac{1}{2}$ sows per farm. Some persons who have young sows and damp quarters report large losses among early spring litters, but with older sows and comfortable pens there has been about the usual mortality.

Litters average 7.2 pigs each. Some increase in deliveries is looked for after September, but until then there will probably be some decrease in the number. Many hogs that would dress 100 pounds have already been sold on the Toronto market.

Regarding cost of feeding, one farmer says: "This is a question worthy of every farmer's attention, but is one grossly neglected. I believe few farmers keep a minute record of expenditure in connection with their hogs." Variations in estimates of cost are surprising, and show a need of keeping more careful accounts. Some are very high and others correspondingly low. The average for summer feeding per hundred pounds is \$4.64, and for winter feeding \$5.31. Quite a number of people claim they can feed hogs just as cheaply in winter as in summer by using roots and keeping the pigs in warm pens.

PETERBOROUGH.

The Tamworths and Yorkshires are both very popular in this county. Quite a number of the farmers are favorable to the Berkshires, and a few to Chester Whites. Any tendency to change is in favor of the Yorkshires and Tamworths, probably slightly in favor of the Yorkshires. Grade sires are used in about 50 per cent. of the sections to a limited extent. There seems to be a tendency to increase the production taking the county as a whole, although in a large percentage of the districts there is likely to be little or no change.

The number of sows decreased slightly in 1905, and has increased again in 1906 to more than in 1904. The size of the average litter is 7.93. The percentage of loss is about normal.

The delivery before September 1st will probably be lighter than in 1905, although a small number of sections report a probability of a few more. The average of the estimates for summer feeding is \$4.68 per cwt., and for winter feeding \$5.55. The range of the estimates for summer feeding is from 3 to 7 cents per lb., and for winter feeding from $4\frac{1}{4}$ to 10 cents per lb.

VICTORIA.

In point of numbers the Yorkshire and Yorkshire grades take the lead. Tamworths and Berkshires are about equal, and a few Chester

Whites are found in different localities. Any change is in favor of Yorkshires first, then the Berkshires, but in most sections there is no disposition to make any change. The Berkshire-Yorkshire is the most popular cross mentioned. In a very small proportion of districts grade sires are used to a limited extent. About fifty per cent. of the reports state there is a tendency to increase the production, and brood sows are selling at high prices. Compared with 1904, 1905 showed a slight decrease in the number of brood sows kept, while 1906 shows an increase. The average number of pigs in each litter to reach weaning age is 7.7. The percentage of loss is about the same as usual. It is very probable that there will be lighter deliveries before September 1st than in 1904 and 1905. The cost of summer feeding varies from \$3 to \$5.50 per cwt., and winter feeding from \$4 to \$6 per cwt. The average for summer feeding is \$4.68 per cwt., and for winter feeding \$5.28 per cwt.

ONTARIO.

The breed most commonly spoken of in returns from this county is the Yorkshire. The Berkshire is also strongly advocated by some and the Tamworth has a few supporters. There is a desire to grade up the ordinary herd by using pure-bred sires, and in cases where pure-bred Yorkshires or Berkshires are kept, crossing is often resorted to. There is room for considerable improvement in many of the sires used, for in nearly every locality there are some grades.

Breeders are exhibiting a great deal of caution regarding any increase of production. A correspondent says: "I do not think that farmers are likely to go into hog raising much more strongly than at present, as it is much better to feed a moderate number at a good profit than to have more to be fed at a loss. The packers cannot resist the temptation to lower prices when they get a fair supply. Besides, other branches of farming are profitable; cattle are a fair price; sheep are high, and horses are extremely high."

There has been little change in the number of brood sows during the last three years. The average farm keeps about two sows each. Spring litters came strong and few losses have occurred. The average size of the litters is 7.4.

The indications are that deliveries will be light during the summer with some improvement during the autumn. Grain is expensive, so feeders are not inclined to use a great deal of it.

The average cost of producing hogs in summer is \$4.56, and in winter \$5.09 per hundred pounds. In discussing the cost of production one correspondent says: "It varies from time to time according to the price of grain, cost of labor, weather conditions, the breeding of the pigs, and the regularity or irregularity of attendance. Sometimes the farmer is rushed with work, and will neglect the hogs for a few days, and that will set them back."

DURHAM.

The popular breeds are the Yorkshires, Berkshires and Tamworths, and stand in favor in order as named. Occasionally a Chester White is found and mention is made of Duroc Jerseys. The Tamworth appears to be growing in favor, being used largely for crossing with both Yorkshires and Berkshires. Appreciating the value of the bacon trade, the farmers generally are giving careful attention to studying the needs of the trade with a view to breeding and feeding the right class of hogs. The care taken in breeding is strongly emphasized by the remarks made concerning the sires used. Only one out of every eight correspondents is aware of any grade sires being used in his locality.

There does not appear to be any strong desire to increase the output. One writer says: "I do not think there will be any great increase; when we raise more hogs we get less money. If we could be sure of \$6 per hundred weight at all times we would supply the market with all the hogs wanted." The scarcity of help and the high price of grains are also affecting production. The average number of sows kept on each farm in 1904 was 2.2; in 1905, 2.4, and in 1906, 2.1. The decrease in the number of sows, a decrease in the size of litters (7.5 pigs each), and an increased loss among young pigs, will cause a rather large shrinkage in the number of hogs to be marketed during the summer.

According to figures received, it costs \$4.52 to produce one hundred pounds in summer and \$5.23 with winter feeding.

NORTHUMBERLAND.

The Yorkshire appears to be the leading breed, with both Tamworths and Berkshires following close up. One writer says: "There has been a slight tendency to go back to the Berkshire, which used to be the prevailing breed, but it has not been general as yet." There is a great deal of crossing done with these breeds. Chester Whites are occasionally used. In some localities they have not yet entirely discarded the grade sires, but improvement is being made in these as well as in the grade sows by grading up.

Owing to a better price having been paid during the past year, there is a disposition on the part of farmers to produce more swine, but there is a shortage of breeding sows which will curtail the output for some time. Still there is a slight increase in the number of sows. The figures given average 2.3 per farmer for 1906; 1.9 for 1905, and 2.1 for 1904. Spring litters run about 7.3 pigs, with losses considerably greater than usual. A number of sows have lost their whole litters. Supplies available for market before September 1st will probably be a little less than during the same period of 1905 and considerably short of 1904.

The cost of growing hogs appears to be less than in most parts of Ontario; \$4.20 is the average cost in summer, and \$5.14 in winter for one hundred pounds.

PRINCE EDWARD.

The Berkshires and Yorkshires are the breeds most favored. There are a number of Chester Whites in the county and a few Tamworths. The Berkshire-Yorkshire cross is well thought of. The correspondents in some sections state there is a desire to follow more closely the bacon type. In some sections correspondents report a tendency to go more into Berkshires and Berkshire crosses. In a large proportion of the sections of the county grade sires are used to a limited extent. In only one case was it suggested that there was a tendency to decrease the production. About one-half of the correspondents are of the opinion there will be no change in their district, owing to a feeling that an increase would bring down the price to an unprofitable basis. In about the same number of sections there is a tendency to increase the production, probably 20 per cent. In some sections farmers are unable to procure young pigs for feeding. The average litter is 7.7. There seems to be an almost general belief that the percentage of loss is greater than usual. One correspondent states: "Losses have been very heavy this year up to this date; from 25 per cent. to 30 per cent. of sows are losing their whole litters."

There was a slight decrease in the number of breeding sows in 1905; and in 1906 a slight increase over 1904. In two or three sections there may be an increase in the delivery of hogs as compared with 1904 and 1905, while in others the output will be practically the same. It will probably be found, however, that, taking the county as a whole, the delivery of hogs will be lighter than during either of the two previous years. There is a great variation in the estimates as to the cost of feeding, ranging from $3\frac{1}{4}$ to 6 cents per pound for summer feeding, and from 4 to 7 cents per pound for winter feeding. The average for summer feeding is $4\frac{1}{2}$ cents per pound, and for winter feeding $5\frac{1}{2}$ cents per pound.

HASTINGS.

The Yorkshires seem to be the favorite breed in this locality, with quite a large number of Berkshires, a fair number of Tamworths and a few Chester Whites; also a small number of Duroc Jerseys. There seems to be an inclination to get fewer of the Tamworths, and go still more extensively into the Yorkshires and Berkshires, with one report stating that there is an inclination to go into Chester Whites, and another report stating that the tendency is to raise a fatter type of hog. In a large number of the sections no tendency to change is reported. One correspondent reports: "Hogs of the bacon type were fed formerly, but farmers are favoring the quicker fattened breeds now."

In a greater proportion of the sections grade sires are used to a limited extent. In several of the sections they appear to be used almost entirely. In most localities there is a tendency to increase the output, although in quite a large number of sections there is no great likelihood of a change. One report states: "All seem anxious to be in the business this year, and young pigs are exceptionally high, although they seem to be quite plentiful." Another correspondent states: "Farmers generally

are satisfied with the price received during the past four months, and if they had reasonable assurance of the continuance of the same, would increase the output considerably." Another report states: "Every farmer is anxious to increase, but sows are not generally doing well this spring. The litters are below the average, and a great many are losing the offspring. Pigs are sold at \$7 per pair."

The number of sows in 1905 shows a slight increase over 1904, and 1906 an increase over the previous year. The average litter is reported to be 7.9. The percentage of loss is about the same as usual. Some sections report the probability of heavier deliveries before the first of September. It is likely, taking the county as a whole, that it will not be any larger than 1905.

The average cost reported for summer feeding is \$4.11 per cwt., and \$5.04 per cwt. for winter feeding. The cost for summer feeding varies from 2½ cents per lb. to 5 cents per lb., and for winter feeding from 3½ to 7 cents per lb. One correspondent states regarding cost of feeding: (Summer), "If properly handled, a bacon hog can be produced ready for market at 4 cents per lb." (Winter), "If kept warm and liberally supplied with sugar beets and clover (cut), at 5 cents per lb." Another correspondent reports: "From carefully conducted experiments during my fourteen years experience, I believe the normal cost to be \$4.50 per cwt., live weight, perhaps a shade less for summer feeding."

LENNOX AND ADDINGTON.

In popularity the breeds in this country come in the following order: Yorkshires, Bérkshires, Tamworths, and Chester Whites, the latter not being found in large numbers. Crosses of these breeds will be found through all sections. There is an inclination to go more into Yorkshires in most of the districts in which it is suggested there is a tendency to change, although in some of the districts there is a desire to add a Berkshire cross. In a large percentage of the sections grade sires are used; in some districts quite extensively. There is a slight disposition to increase the output, but not very extensively. There seems to be a desire to increase the output more by buying young pigs than by breeding. There is practically no difference between the number of breeding sows kept in 1904, 1905 and 1906, except that there was a slight decrease in 1905. The average litter is 7.7. The loss appeared to be about normal, a few sections reporting a greater loss, and several sections less loss. A large proportion of the districts report that the delivery before the 1st of September will be less than 1905, and very much less than 1904. In some sections the delivery will probably be about the same, and in some there will probably be a slight increase, but covering the whole country there will probably be fewer hogs shipped before the 1st of September than in 1905. The estimates of cost of summer feeding range from 3½ to 7 cents per lb., the average being \$4.53 per cwt. The estimates for winter feeding range from 4 to 7 cents per lb., the average being \$5.32 per cwt.

FRONTENAC.

The principal breed in this county is the Yorkshire. There appears to be about equal numbers of Berkshires, Tamworths and Chester Whites, with a very occasional trace of Duroc Jerseys. There seems to be no indication of a tendency to change unless it is slightly in favor of the bacon type. Grade sires are used in quite a number of sections throughout the county. There is a disposition in most districts to increase the output. The average litter is 8, and it seems to have been a fairly good year, the percentage of loss not being larger than is usually the case. The number of sows kept by the average farmer has increased each year since 1904; the number of sows kept in 1906 being largely in excess of those kept in 1904. One correspondent, however, states regarding his section: "I cannot say as to breeding sows, but very careful enquiry shows that the number of pigs raised in 1904 will equal that of 1905 and 1906 combined."

In only one case is there a report that the delivery up to September 1st will be less than during the same period for 1904 and 1905. In some other cases the report was that there would likely be no change in the delivery. In most cases, however, the reports favored the likelihood of a decided increase.

The reports as to cost of feeding show an average of \$4.16 per cwt. for summer feeding, and \$4.87 per cwt. for winter feeding; reports varying from 2 to 5½ cents per pound for summer feeding and 3 to 6 cents per pound for winter feeding. One correspondent reports as follows: "With clover and rape pasture and a good supply of whey, about 4½ cents in summer, and with skim milk and grain about 5½ cents in winter."

LEEDS.

The favorite breed in this county is Yorkshire. There are quite a number of Berkshires and Tamworths, and occasionally some Chester Whites and a few Duroc Jerseys. Crosses of all these breeds are also found. In this section they appear to be anxious to keep strictly along the line of the bacon type, and in other sections where they are not producing this type at the present time, there is a tendency to change to the bacon hog. In several sections grade sires seem to be used quite extensively. In some sections, however, they are not used at all, and in others to only a very limited extent. There seems to be every expectation of a general increase in production throughout the county. About 8 per cent. of the correspondents report a probable decrease; about 12 per cent. no change, and about 80 per cent. an increase. The reports show a small increase in the number of breeding sows in 1905 and a further slight increase in 1906. The average size of the litter is reported as 7.97. There seems to be a greater percentage of loss than usual this year in quite a number of sections. Taking the county as a whole, there will probably be an increase in the delivery before the 1st of September. Quite a large number of the sections, however, report a decrease, and others that there will probably be no change from the deliveries of 1904.

and 1905. The estimates of the cost of feeding vary from 3 to 10 cents in summer and 4 to 10 cents in winter. The average of the various estimates for summer feeding is \$4.70 per cwt., and for winter feeding \$5.90 per cwt.

GRENVILLE.

Taking the county as a whole, the most popular breed is the Yorkshire. The popularity of the Berkshire, Tamworth, and Chester White is about evenly divided. In some special districts, however, the Chester White breed is very strong in numbers, while in several other sections there is a tendency to go more into Chester Whites. The most general disposition, however, is to go more into the Yorkshire breed. In a great many districts there are a number of grade sires used, while one report states they are practically all grade sires in that section. There is a general desire to increase the output, but young pigs are very scarce and very high in price; more brood sows will probably be kept. One report states: "Would increase the output if they could get the pigs, but cannot get young pigs. Some are paying \$3, and even \$4, for four weeks' old pigs." There is a very slight increase in the number of sows, in both 1905 and 1906, over 1904. The average litter is 6.7, and the percentage of loss is considered to be considerably greater than usual. According to the reports, there is no doubt there will be a lighter delivery from this county before September 1st, than in 1904 and 1905. Some few sections, however, report an increase. The average estimate of cost for summer feeding is \$4.60 per cwt., and \$5.35 per cwt. for winter feeding. The lowest and highest estimates for summer feeding are \$3.50 per cwt. and \$5.50 per cwt., and for winter feeding \$4 and \$6.75 per cwt.

DUNDAS.

The farmers in this county show very little preference for any particular breed. There are about the same number of Yorkshires, Berkshires and Tamworths (including crosses of each), with perhaps a few less of the Chester White breed. In quite a number of the sections there is an inclination to use more of the Berkshire or of the Chester White in crossing with the Yorkshire or the Tamworth. One correspondent states: "Few if any pure-breds are kept in this district except sires. The Ohio Improved Chester White has quite a strong foothold here. The feeders are principally the get of a top cross of Ohio Improved Chester White or Berkshire. Very few Yorkshires are raised here. Unfortunately, the buyers here do not discriminate between the short thick fat and the bacon type, and the hog sought after by the feeders here is the one that will put pounds on the fastest anywhere over the body." Another correspondent states: "The tendency of late has been to cross-breed, also to breed fat hogs again, as we find we can produce them cheaper, being better grass pigs. Instead of breeding the thin bacon hog or the thick fat pig, we have been crossing the Yorkshire and Chester White, and the Berkshire and Tamworth."

Grade sires are used to a limited extent in quite a number of sections, and in several sections quite extensively. There is a desire in a number of districts to purchase young pigs for feeding, but, as is the case in a number of the eastern counties, they are not available. This shows there is a desire to increase the output, which will probably have an effect about November or December. A report states: "The hog question was never on a better footing than at present. Spring pigs are being bought at extraordinary prices. The market is very encouraging, and the by-products of our dairy industry will be larger this season than ever, so that more hogs will be fed." The number of brood sows will be considerably more than in 1905, about the same number as in 1904. The average litter is 7.16. Reports from most sections give a very high percentage of loss among young pigs. Present indications are that deliveries will be considerably less before September 1st than in either 1904 or 1905. Some sections, however, report a probable increase. The cost of feeding varies from \$3.25 to \$6 per cwt. for summer feeding and \$4 to \$8 for winter feeding. The average of estimates for summer feeding is \$4.47 per cwt., and for winter feeding \$5.48 per cwt.

STORMONT.

The popularity of the breeds is in the order named: Yorkshires, Berkshires, Chester Whites and Tamworths, apparently not very many of the latter. The Yorkshire seems to be gaining ground, a favorite cross being either Yorkshire-Berkshire or Yorkshire-Chester White. In several sections there appears a disposition to go more to Berkshires, and in one section from Berkshires to Chester Whites. Grade sires are used to a limited extent in quite a number of districts. There is quite an evident feeling that it is desirable to increase the output on account of prices, but in a large number of sections there seems to be a great scarcity of young pigs. The number of breeding sows will show quite a large increase in the county, probably about 30 per cent. over 1904. The average litter is 7.31. Sixty per cent. of the correspondents report a greater loss than usual; ten per cent. report a more favorable year, while thirty per cent. state the loss was about the same as is usually the case. The report from one section states: "Farmers are increasing the number of breeding sows every year. This year they are raising some fine young sows, principally Yorkshires." The report from another district states: The average farmer keeps about two brood sows right along, regardless of market fluctuations." The correspondents are about equally divided on the question of a greater or less delivery up to September 1st, so that it is probable the output from the county will average about the same as 1905. Some sections may send heavier deliveries and others lighter. The average for cost of summer feeding is \$4.27 per cwt., and for winter feeding is \$5.17 per cwt. The highest estimate for winter feeding is \$6.25 per cwt., and the lowest \$4 per cwt. The highest for summer feeding is \$5.50 per cwt., and the lowest \$3 per cwt.

GLENGARRY.

The Yorkshire and the Berkshire are the favorite breeds. There are a few Tamworths, and fewer Chester Whites. There is an inclination in quite a number of sections to get more extensively into Yorkshires. This seems to be a special feature of this county. In almost all sections grade sires are used to a limited extent, and in several sections quite extensively. There is an evident desire among the farmers to procure more pigs for feeding, but they are scarce, and there is great difficulty in getting them. There also seems to be a shortage of brood sows. One correspondent says: "There is a shortage, and will be until young sows come to a breeding age." Another says: "Generally at this time of year people have a lot of litters on hand, and formerly it was customary to sell them after weaning, but pork looks so good at present that the majority will hold on to them. So far as the increase is concerned, it is believed the output will be about the same, as the prices fluctuate so readily, the farmers are afraid to deal extensively." Another report states: "All are eager to increase their output. It is very hard to purchase either young pigs or brood sows." Another report: "The general opinion is that the real bacon hog will be scarce, as a large percentage of the brood sows were sold lately because of the high price of pork." The number of brood sows kept in 1906 will show an increase over 1905 and a very slight increase over 1904. The average litter is 6.3, and it is the almost general opinion that there was a much greater percentage of loss this year than usual. All correspondents, with the exception of one, report a probable decrease in the delivery up to September 1st, as compared with 1905. The estimates as to cost of summer feeding vary from \$3 per cwt. to \$5 per cwt., and for winter feeding from \$4.50 per cwt. to \$10 per cwt. The average for summer feeding is \$4 per cwt., and \$5.75 per cwt. for winter feeding.

PRESCOTT.

The principal breeds in this county are Yorkshires and Berkshires, while in some sections there are a number of Chester Whites. Some correspondents report a tendency to go still more into the Yorkshires and Berkshires, while one correspondent reports a disposition to go more into Chester Whites. In very few districts are pure-bred sires used entirely. In some districts the majority of the sires used are grades. There appears to be a disposition to increase the output in this county, although there has been practically no change in the number of breeding sows since 1904. The average size of the litter is 7.5, and the correspondents state that the loss is much larger than usual. The general idea is that the delivery up to September 1st will be considerably less than up to September 1st of 1904 and 1905. The only correspondent giving an estimate of cost of feeding in this county places the cost of summer feeding at from 6c. to 7c. per lb., and for winter feeding at from 1 to 1½ cents more.

RUSSELL.

The most popular breed is the Yorkshire. The Berkshire and Tamworth are also quite plentiful in some sections. Besides these breeds there are also a smaller number of Chester Whites and a few Duroc Jerseys. The Yorkshire-Berkshire cross is well thought of, and some prefer the Yorkshire-Chester White. Any tendency to change the type is given in the following reports from different sections: "Whatever changes have been made were from Yorkshires to Chester Whites. Very few, if any, are shipped to the packers; a large local lumbering village absorbing all, or nearly all, produced." "The farmers in this section usually market hogs weighing from 200 to 250 lbs., which is somewhat lighter than previously, formerly weighing 300 lbs." "Owing to the addition of bacon boars through the township, the bacon type of hog is slowly but surely replacing the thick fat hog. Farmers are breeding their sows to more bacon type boars, and replacing their old sows with grades from these boars." In nearly all sections of the county, grade sires are used to a limited extent. There is an evident desire to increase the output if it could be done by purchasing young pigs, which at the present time are not available. One report states: "The production will likely be less than last year. There are about the same number of brood sows, but a greater loss of young pigs." There is also a scarcity of brood sows for sale, although the number of sows kept has increased each year since 1904. It is suggested, however, that a number of these are young sows, which is given as a reason for a greater percentage of loss among litters this spring, and also for the young pigs coming later than usual. The average litter is given as 8. There does not seem to be a likelihood of deliveries being any heavier before September 1st of this year than in 1905. The lowest and highest estimates of cost for summer feeding are \$2.50 per cwt., and \$5 per cwt. respectively, and for winter feeding \$3.50 per cwt. and \$6 per cwt. The average for summer feeding is \$4.15 per cwt., and for winter feeding \$4.95 per cwt.

CARLETON.

Yorkshires are used most extensively in this county, with quite a good number of Berkshires; there are also a few Chester Whites and a few Tamworths. There is in some sections a reported tendency to go more into Yorkshires, and in one or two cases to go more to Berkshires and to Chester Whites. About fifty per cent. of the correspondents report that grade sires are used to some extent in their districts. There is a fairly confident feeling, and it is probable there will be a slight increase in the production in this county. There is a slight increase in the number of sows in both 1905 and 1906. The average litter is 7.4, and the percentage of loss is about normal.

It is expected the deliveries for the county will be heavier than to September 1st, 1905. The average of estimates of cost for summer feeding is \$4.44 per cwt., and for winter feeding \$5.50 per cwt. The range

of estimates for summer feeding is from \$3.25 to \$5.50 per cwt., and for winter feeding \$4 to \$6 per cwt. One correspondent reports: "Farmers in this vicinity do not raise hogs extensively, and the general feeling is that, owing to high prices of grains, there is very little profit for the average feeder. Where an almost exclusive meal ration is fed, I would say $6\frac{1}{2}$ cents per lb.; if roots and skim milk are fed with ration, cost would be considerably less; and in summer on good pasture, with skim milk, the cost should not be above $3\frac{3}{4}$ cents per lb."

LANARK.

The breeds in this county are found in the greatest numbers according to the following order: Yorkshires, Berkshires, Chester Whites and Tamworths. When any tendency to change is noted it is principally more to bacon hog type, although in one or two sections it is stated there is a tendency to go the other way. In a large percentage of districts grade sires are used to some extent. In most districts there is a disposition to increase the output. Considerably more breeding sows are being kept than in either 1904 or 1905. The size of the average litter is 8.45, the percentage of loss being about normal.

The delivery before September 1st will be heavier than in 1905, in some sections correspondents report heavier than ever before. In some local sections, however, deliveries may be slightly lighter. One correspondent states: "Delivery before September 1st will be much heavier. Cannot remember at any previous time so many early litters as there are this year." The average of estimates of cost give the following: for summer feeding, \$4.30 per cwt.; winter feeding, \$5.37 per cwt. Estimates range from $3\frac{1}{2}$ to 6 cent per lb. for summer feeding, and $4\frac{1}{2}$ to 6 cents per lb. for winter feeding.

RENFREW.

The principal breeds in the various sections are Yorkshires and Berkshires, with, in some districts, Chester Whites and Tamworths. There is a tendency in a number of sections to go more into Yorkshires, and in two or three districts to Yorkshire-Berkshire cross. In almost all districts correspondents report the use of grade sires to some extent, in some places quite largely, though generally the feeling is that they are used much less than formerly. The tendency is to increase the production, taking the county as a whole; some sections report otherwise. One correspondent states: "The farmers of this municipality do not raise hogs for market. The most of them do not raise enough for their own use."

There is a slight increase over both 1904 and 1905 in the number of sows kept. The average litter is 7.56, and the percentage of loss reported is about normal, although a very large proportion of litters do not come until later than the time at which the reports were made. The delivery before September 1st will probably be slightly lighter than in 1905. Regarding cost of feeding, very few correspondents make any statement. The average of those given for summer feeding is \$5.50 per cwt., and for

winter feeding \$8.12 per cwt., the estimates ranging from \$4.50 to \$8 per cwt. for summer feeding, and \$5.50 to \$12 per cwt. for winter feeding.

HALIBURTON.

The hogs raised in this county are chiefly for home consumption. Not much interest is taken in hog raising. Those raised are mostly grades of the Berkshire and Yorkshire breeds, and there is very little tendency to make any change, or go more extensively into the business. A number of grade sires are used.

MUSKOKA.

Little attention appears to be paid to hog raising here. Where pure-breds are kept they are Berkshires, Yorkshires or Chester Whites, but in most cases both boars and sows are grades. As not sufficient pigs are raised to supply local markets, not much attention is paid to type. The scarcity of pigs seems due to the cost of feed, which is so high as to make farmers think the business not very profitable, even in summer. There is little tendency to increase production.

Few farmers keep more than one brood sow, and many have none at all. At the time of writing sows were just beginning to farrow, so little information could be given regarding litters.

Figures are not available as to the cost of feeding hogs.

PARRY SOUND.

The principal breed in this district is the Berkshire, apparently being more numerous than all others together. Next come the Yorkshires and Tamworths, with very few Chester Whites and some Poland Chinas. Any inclination there is to change seems to be towards the Yorkshires, and in some cases more to Berkshire, but there does not seem to be very much disposition to make any change. In almost all sections grade sires are used; in a great many cases almost altogether. It seems likely that there will be no change in the output of this district at the present time. In a great many of the sections the number grown is sufficient for home consumption only. The number of sows in 1904 and 1905 is apparently the same, with a slight increase in 1906. The average litter is 7.21. A very small proportion of the sows have farrowed yet, so that in a very few cases can an estimate be given regarding the percentage of loss. The delivery before September 1st will be practically the same as in 1905. There are very few estimates as to the cost of feeding. What there are range from 3 to 6 cents per lb. in summer, and $4\frac{1}{2}$ to 7 cents per lb. in winter; the average for summer being \$4.75 per cwt., and \$5.70 per cwt. for winter feeding. There appears to be practically no winter feeding done, and the number of hogs in summer is not sufficient for home consumption.

NIPISSING, MANITOULIN, ALGOMA, THUNDER BAY AND RAINY RIVER.

In most places in these districts there appears to have been but little attention paid to hog raising as yet. What hogs are raised are

used by those who feed them, or are sold to the local markets. Some pure-bred Berkshires, Yorkshires, Tamworths and Chester Whites are kept but grades are generally used. It is likely production will increase slowly but will not be more than enough for home markets for some time.

SUMMARY.*

POPULARITY OF BREEDS.

Yorkshires : Out of 42 counties the Yorkshire is reported to be the principal breed in 33, and in 7 others is a tie with some other breed for first position. In one county Yorkshires are in fourth place, and one county fifth. In 14 counties of the 33 first mentioned the Yorkshires are far in excess of the next most popular breed.

Berkshires : In one county the Berkshire is the principal breed, and in 7 divides first place with some other breed. In 23 counties the Berkshire comes second, while in 8 counties they divide honors for second place. In 3 counties they are third.

Tamworths : In 2 counties the Tamworths tie with some other breed for position of most popular breed. In 2 counties they are second, and in 8 counties equal with some other breed as second choice. In 23 counties they come third; in 10 of these counties as well as in 6 others they are in small numbers.

Chester Whites : In one county Chester Whites tie with some other breed for position of being most popular, and are second in 1 county and a tie for second place in 2 counties. In 5 counties Chester Whites are third, and in 2 other counties equal with some other breed for third place; in 18 counties they are in fourth place, an explanation from some of these counties stating they are very few in numbers.

Duroc Jerseys and Poland Chinas : These breeds are seldom mentioned except in the counties of Essex and Kent.

Yorkshires are found in the strongest numbers, comparatively, in counties west of the County of Ontario, while the Chester Whites are mostly found in counties east of the County of Durham. The Berkshires are fairly evenly divided in almost all counties. The Tamworths are mostly used in sections taking in the counties of Bruce, Grey, Simcoe, Dufferin, Peterborough, and Victoria, and counties Northumberland to Dundas. While all crosses are used, there is no doubt that the most popular cross throughout the Province is a cross between the Yorkshire and the Berkshire.

Taking the Province as a whole, the evident tendency is to produce more hogs of the approved bacon type. In the western part of the

* The reports from the Districts of Haliburton, Muskoka, Parry Sound, Nipissing, Algoma, Manitoulin, Thunder Bay and Rainy River are not included in the summary, owing to the fact that hogs are not grown in these districts to any considerable extent. The report as to cost of feeding from the county of Prescott was not sufficiently definite to include in average cost of feeding for the Province.

Province there is an inclination to use more Berkshires than heretofore for the purpose of crossing, principally with the Yorkshire, although crosses with other breeds are also noted. In the eastern part of the Province the tendency in most sections is to go more to Yorkshires. In one or two counties the Chester Whites find considerable favor; also the Tamworths, although the general impression given by the reports is that these two breeds are both decreasing in popularity. It may be noted, however, that in the counties where the Tamworths are mostly found, there seems to be no general tendency to change; the principal breed in these counties, however, is Yorkshire, the Berkshire being slightly in excess of the Tamworths. It would also appear that while the Yorkshires are increasing in the greatest numbers throughout the Province, the Berkshires are showing a higher percentage of gain.

QUALITY OF SIRES.

Pure bred sires are used almost entirely in 25 per cent. of the counties, while in about 20 per cent. grade sires are used to a limited extent. In about 35 per cent. of the counties grade sires are used still more frequently, while in about 20 per cent. they are found in a great many sections, and, as some of the correspondents state, are used in some districts of their counties almost altogether. As a rule the counties in which the smallest number of grade sires are used are west of the county of Hastings, and the district taking in the north-western peninsula will be found to be freer from the use of grade sires than any other section of the Province, although there are other individual counties from which the reports are just as favorable. Considerable numbers of grade sires are still being used in many sections of the eastern counties.

PRODUCTION.

The general tendency throughout the Province is slightly to increase production. In the eastern part of the Province it has been customary for many farmers to depend upon breeders in their locality for their supply of young pigs for feeding; it has been noted that the demand this spring considerably exceeds the supply, the breeders who usually sell their pigs retaining them this year on account of the good prices for hogs. It is quite probable that the feeders who are short this year may be inclined to breed pigs for themselves another year, which would add considerably to the production in that locality. While the tendency throughout the Province is to increase as above, considerable caution is observed among many individual breeders and feeders not to go into the business too extensively, for fear that over production might bring prices down to an unprofitable point.

The number of breeding sows was decreased considerably during 1905, while 1906 shows an increase in the number not only over 1905 but also over 1904. The reports indicate that in 21 counties the sows were decreased in 1905, while 13 counties report slight increases and eight counties report no change. Comparing 1906 with 1905, 35 counties

report increases while only two report decreases, and five counties no change in the number of sows. Comparing 1906 with 1904, in 26 counties correspondents report increases in sows, while in 9 counties decreases are reported, and in seven counties no change.

The districts in which increases are noted in 1905 over 1904 are confined mostly to the eastern counties. It is also worthy of notice that in the comparison of 1906 with 1904, the reports show that the counties in which a decrease is reported, are practically all in the western part of the Province; also that the increases in the number of breeding sows are largest in the eastern counties. This would indicate that the eastern part of the Province is relatively increasing production much more rapidly than farther west. In almost all portions of the Province there is an apparent good demand for brood sows which considerably exceeds the supply.

While the number of brood sows has increased almost generally throughout the Province since 1905, the reports of most counties indicate that the delivery of hogs up to September 1st will be lighter than 1905. About 65 per cent. of the counties report lighter deliveries probable, while about 20 per cent. report no change. This apparently indicates that, taking into consideration the large reported increase of breeding sows, with the lighter deliveries before the 1st of September, hogs will be marketed very heavily later in the fall.

The percentage of loss in young pigs, however, is greater than usual in a large proportion of the counties, which will have its effect upon the fall deliveries. Taking the Province as a whole, the average number of pigs in spring litters to reach weaning age this season is 7.61. The average size of the spring litter from the 17 counties which report a normal loss is 7.77, the average from the two counties reporting less losses than usual, 8.35, while the average from 23 counties reporting more loss than usual is 7.43. A comparison of these averages will demonstrate that in years when there is the usual percentage of loss throughout the Province, the average number of pigs per litter to reach weaning age is 7.77.

COST OF FEEDING.

Taking the averages of the cost of feeding as given in the different counties, the average for the Province for summer feeding is \$4.51 per cwt., and for winter feeding \$5.38 per cwt. In very few cases do correspondents state that the figures given are the results of actual experiments. In a number of cases no information is given as to whether the figures are the result of experiment or an estimate. In a small number of cases, however, it is stated that experiments have been made and that the figures given are the result of such experiments. It is almost invariably noticed where this is done that for both summer and winter feeding the cost is considerably below the average given above. A number of correspondents, especially in western Ontario, state that with comfortable quarters and roots, the cost of feeding is no greater in winter than in summer.

WHERE ARE WE AT?

By G. E. DAY, PROFESSOR OF ANIMAL HUSBANDRY, O.A.C., GUELPH.

During the last winter a very lively discussion has been carried on in the agricultural press regarding the question of bacon production. The whole discussion was started by the fact that Canadian packers fail to discriminate in price between the bacon hog and the fat type. Around this storm centre the discussion has raged, and a great many matters of greater or less importance have been swept from their natural place by this inky cyclone, and whirled before the public in such fantastic fashion that it would be little wonder if many men failed to remember their natural aspect. Perhaps it is still rather early to emerge from the storm cellar, and yet the sooner we earnestly set to work to make the best use of what is left us, the better it will be for all concerned.

Among the points brought into the discussion is the advisability of giving up breeding the bacon hog, and going into the production of the fat hog. When a man is on the top of a high fence and makes up his mind to jump down, he will naturally take a lively interest in the spot where he will alight. When we talk of dropping the bacon hog and taking up the production of the fat type, we should carefully consider what would be the consequence of such a step. Judging from the points which have been brought out in the discussion, we are led to conclude that the Canadian packer can handle a limited number of fat hogs to good advantage; that he can, in fact, make as much money out of a certain number of fat hogs as he can out of an equal number of bacon hogs. While this is true, it does not follow that if all Canadian hogs were of the fat type, the profits would be the same as they are at present, nor does it follow that the prices received by the farmer would be equal to those of to-day. It does not require much thought to understand how this comes about. There is a certain home demand for fat hogs, and home-grown fat hogs can be used to advantage to supply that demand. But, just so soon as that demand is supplied, and an attempt is made to dispose of the surplus in Great Britain, we find ourselves face to face with American competition. It is right here that the bacon hog helps us out of our difficulties. He can go to the British market, and keep out of direct competition with his fat cousin; but if we attempted to market the products of the fat hog in Britain, we would soon find ourselves put out of business by American competition. There is no question that the Americans can give us "cards and spades" and beat us out in the production of fat hogs. With their immense and varied home market, and their cheap corn, they have every advantage in their favor. Thus, we see that the bacon hog enables us to dispose of our surplus product in a profitable market. Remove the bacon hog, and the possibility of disposing of our surplus product to advantage disappears. It should not be difficult for the average intellect to grasp the situation, and enable our farmers to realize that the present good prices for fat hogs are rendered possible by the existence of the bacon hog. The bacon hog is the key to

the situation, it opens the door for our surplus product, and prevents congestion. If we throw away the key, our hog industry will dwindle away to the position it occupied years ago, becoming practically limited to supplying the local demand. Upon which side of the fence will our farmers jump? Surely none of them wish to become impaled upon the snout of a large-sized American fat hog.

Another question which has been raised is whether it pays Canadian farmers to feed hogs of any kind. Some writers have gone so far as practically to advocate that farmers should drop out of the hog business altogether. This position is so unreasonable and so childish as scarcely to deserve notice. We find men who cannot make the raising of sugar beets pay; other men engage in the operation and make a fair profit. We also find men who cannot make dairying pay, and others who find it a very profitable business. The same may be said of almost any business undertaking, whether connected with agriculture or not, and it would be a strange thing if the feeding of hogs were any exception to the general rule. While everyone will admit that it is possible to lose money on hogs, at the same time it is possible to make money, as has been demonstrated a great many times. Those who feel sure they are losing money in the hog business had better stay out of it, but they should have the good grace to give those men who are engaged in it credit for understanding their business, and being their own judges as to whether they should stay in it or not.

But perhaps the most plaintive and most general wail comes from those who believe that it costs a great deal more to produce the bacon hog than to produce hogs of the fat type. This belief is extremely widespread, and probably has a firm place in the minds of ninety-nine out of one hundred farmers. When we come to sift the evidence, however, we cannot find a particle of proof in favor of this theory. At both Guelph and Ottawa it has been found impossible to demonstrate that there is any fixed relation between the type of the pig and the cost of producing one hundred pounds increase in weight. If a pig is thrifty, has a good constitution and good digestive organs, it can make good use of its food, whether it belongs to the bacon or to the fat type. In addition to the work done at Guelph and at Ottawa, the Iowa Experiment Station conducted three experiments with six different breeds of swine, and a comparison of their results with the results obtained at Guelph with the same six breeds should convince any thoughtful person that breed has practically nothing to do with economical production. It is worthy of note that one or two experiments amount to practically nothing so far as establishing a certain point is concerned. In our own experiments, which we are carrying on with cross-bred swine, we have two litters of pigs of identically the same breeding, and yet one group is making very much cheaper gains than the other. If these two groups had happened to belong to different breeds, the person unfamiliar with experimental work would likely conclude that the difference was solely attributable to the breed. Since they are of identically the same breeding, and since the

food is exactly the same for both groups, it follows that there must be some other cause for this difference in cost. Individuality is far more effective than breed or type in determining the cost of production. This case is quoted simply to show the uncertainty of a single experiment, and yet you will find a great many people thoroughly convinced that their view is the correct one for the simple reason that some one, and possibly very imperfect, test happened to result in a certain way. It shows how careful we must be in drawing conclusions, and when we study all available data regarding the relative cost of producing one hundred pounds increase in weight in bacon hogs and in fat hogs, we are forced to the conclusion that, to say the least, it has never been proved, other things being equal, that the bacon hog is any more expensive to produce than the fat hog.

A very important problem which has attracted a good deal of attention throughout this discussion, and which is worthy of careful research, is the problem of the average cost of producing hogs of suitable weight for bacon purposes. We find the cost of raising hogs variously estimated, some claiming that they can raise their hogs at less than four cents per pound, live weight, and others that it costs in the neighborhood of six cents per pound. Unfortunately, we have not sufficient data at hand to enable us to make an authoritative statement. We are accumulating information as rapidly as possible, and so far as our information goes, it indicates that if moderate market values are attached to the foods consumed, the cost may range all the way from a little over four cents per pound to somewhere in the neighborhood of five cents per pound. Methods of feeding and the individuality of the pigs influence results, and it will require considerable time to establish anything which may be regarded as fully satisfactory. The William Davies people, of Toronto, have shown their interest in this problem in a practical way, and are offering to farmers who will keep an accurate record of all foods consumed by their pigs from the time they are weaned until they are ready for market, and who will also report the weights of the pigs at weaning time and at the time of marketing, an advance of 50 cents per hundred over the prevailing market price at the time the pigs are marketed. This very liberal offer has been accepted by quite a number of farmers, and we expect quite a large number yet to take advantage of it. The information thus obtained should be of great value.

To discuss thoroughly this whole question would require a great deal more space than should be given to one article, but an attempt has been made to present a few important points for careful consideration, and we trust that readers will be careful in drawing conclusions, and that they will consider all phases of the matter before they rashly make up their minds to sacrifice the reputation Canada has obtained in export bacon. The more we reflect upon the matter, the firmer becomes the conviction that Canada has nothing to gain and everything to lose if she abandons the production of the bacon hog.

INDEX.

Counties and Districts.	Number of Hogs sold or slaughtered during year ending June 30, 1905.	Page.
Algoma.....	6,817	29
Brant	40,354	9
Bruce	76,402	13
Carleton	28,472	27
Dufferin	44,461	16
Dundas	32,711	24
Durham	47,753	20
Elgin	81,440	4
Essex	102,880	2
Frontenac	24,707	23
Glengarry	20,981	26
Grenville	21,799	24
Grey	105,917	14
Haldimand	32,779	5
Haliburton.....	2,984	29
Halton	32,561	16
Hastings	57,027	21
Huron	99,437	12
Kent.....	117,007	3
Lambton	70,701	7
Lanark	26,269	28
Leeds	37,235	23
Lennox and Addington.....	30,781	22
Lincoln	26,465	6
Manitoulin	5,965	29
Middlesex	87,408	8
Muskoka	5,378	29
Nipissing	3,820	29
Norfolk	54,540	5
Northumberland	55,416	20
Ontario	68,382	19
Oxford	90,375	8
Parry Sound.....	6,869	29
Peel.....	39,680	17
Perth.....	91,548	12
Peterborough	39,410	18
Prescott	12,556	26
Prince Edward.....	25,861	21
Renfrew	18,613	28
Russell	9,901	27
Simcoe	112,888	15
Stormont	21,808	25
Victoria	42,640	18
Waterloo	62,884	11
Weiland	23,196	6
Wellington	94,358	10
Wentworth	41,216	7
York	84,931	17

Ontario Department of Agriculture.

ONTARIO AGRICULTURAL COLLEGE AND EXPERIMENTAL FARM

THE COMMON FUNGUS AND INSECT PESTS OF GROWING VEGETABLE CROPS.

BY WM. LOCHHEAD AND T. D. JARVIS.

INTRODUCTION.

In the following pages an attempt is made to describe concisely the common fungus and insect enemies of vegetable crops, and to state briefly the best methods of controlling these pests. It is believed that the publication of such information in bulletin form will fill a long-felt want. While criticism may, perhaps, be made of some of the treatments recommended, to the effect that they are too expensive, too burdensome, or but partially effective, it can at least be said that they are the best that up to the present have been devised. It is true that with some vegetable crops the returns are so small that every means must be taken to reduce the cost of growing and marketing the crop. As a consequence, some growers will, perhaps, prefer to replant rather than practise the treatments recommended in this bulletin.

Experience will, we are sure, convince the majority of growers that spraying is, after all, a cheap form of crop insurance. It may be true that with some diseases only a few plants die, and the grower does not lose much, yet it often happens that the disease destroys practically the whole crop, and the grower is left without anything to show for his work. The spray-pump should be in evidence in every vegetable garden, and to get the best results from spraying, the following rules should be followed as closely as possible:—

1. Buy the best spray-pump outfit in the market.
2. Have stock solutions of Bordeaux and other common substances in readiness for spraying.
3. Spray thoroughly and intelligently, *i.e.*, know the *habits* of the fungi and insects, the *preparation* of the best remedies, and the *best time for the application* of the remedies. It should be remembered that prevention of fungus disease is possible, but their cure is hardly practicable.

DISEASES.

Diseases of plants, for convenience of consideration, may be grouped as follows: First, those caused by (a) insects and other animals, (b) fungi, (c) bacteria, (d) slime moulds, and (e) flowering plants; and, second, the unfavorable action of soil, drought, heat, wind, lightning, frost, and sun scald. Sometimes two or more of these causes may operate to bring about a diseased condition of the plant. In particular we may note that plants which have been rendered unhealthy by excessive moisture, excessive dryness, or imperfect access of light and air, are more liable to attack from insects and fungi. It is not always easy to tell when a plant is in a diseased condition, for the condition of a healthy plant varies between fixed limits, and it is only when these limits are exceeded in either direction that the life of the plant is threatened, and there is disease instead of health. We sometimes group the causes which bring about diseases in plants as external and internal, but it is very probable that the so-called internal causes will be found to be nothing more than external causes acting in an indirect manner.

Young plants are, as a rule, more liable to attack by fungi and insects than older plants, because their tissues are softer and their cuticle thinner.

In the following pages attention will be given only to those diseases in plants which are caused by insects, fungi, and slime moulds.

The losses produced every year by the action of insects and fungi on vegetable crops are very large, amounting in Ontario to probably one-half million dollars. While it may be true that some of these losses cannot be averted, yet it is also true that a large percentage of them can be prevented by proper treatment. On account of the low prices prevailing in the vegetable markets, the method becomes a very important factor in the control of these pests. In some cases the cost of treatment would amount to as much as the market price of the vegetable. It is our object in the following pages to recommend such treatments as have been found effective and practicable in vegetable gardens cultivated on a commercial basis.

A few words about the habits of fungi and insects. Fungi are a group of lower plants (without green-coloring matter) that produce spores instead of seeds. The body of a fungus may be very simple, composed of a few threads, or it may be more complex, composed of many threads matted together. The fungus derives its nourishment from the cells of the plant which it attacks. Sometimes the threads live on the surface of the plant (*e.g.*, the Powdery Mildews), but more frequently they live within the plant, either between or within the cells. Fungi produce, roughly speaking, two kinds of spores—*summer* spores, capable of developing threads as soon as they are set free; and *resting*, or *winter* spores, requiring a period of rest before germinating. Spores are carried by such agencies as wind and water, and, coming into contact with a suitable host plant, they develop threads which may enter through wounds

or through the skin of the plant. Once within, the mass of threads grows rapidly at the expense of the cells of the host plant, and a diseased condition ensues. Every fungus produces its own characteristic disease and injury, so that it is possible to diagnose the causes of most plant diseases from the external appearances.

The best method of dealing with fungous diseases is along the line of *prevention of infection*. Careful attention to all wounds, when spores may find entrance; the rotation of crops, so that the resting spores of one crop may not infect the succeeding ones; careful attention to the destruction of weeds that may be diseased and infect useful plants; the use of old rather than fresh manures; the selection of plump, healthy, and disease-resisting seeds; and the timely and early application of fungicides, are some of the methods usually employed to prevent infection.

Insects do fully as much harm as parasitic fungi, and some are also very difficult to control. Wire-worms, White Grubs, and Root-maggots pass their grub or larval stage in the ground, and feed on the roots of plants. Potato "Bugs," asparagus beetles, and grubs, squash-bugs, and plant lice, feed on the stems and leaves, and are more readily treated.

For the practical grower, it is important to know that insects are divided into two classes: the *biting* insects, that chew their food, and the *sucking* insects. The former can be poisoned by arsenical poisons, but the latter cannot, and must be treated by substances that kill by contact, such as soaps, kerosene emulsions, and tobacco washes. It is also very important to know the life-histories of the most injurious insects, so that they may be attacked during the most vulnerable period of their life.

Much can be done by such *cultural* methods as rotation of crops, high culture, careful removal and burning of rubbish and weeds, and plowing. Short rotations, for example, furnish unfavorable conditions for white grubs, wire-worms, and root-lice. The general plan is to change the crop so frequently that it becomes impossible for any insect to pass through its life stages without being seriously disturbed, and its food supply destroyed. Deep fall-plowing is also an excellent method of controlling wire-worms and white-grubs, and is effective against grasshoppers and cutworms. As for High Culture, it may be said that vigorous, healthy-growing plants are far less liable to attack, and are far more likely to recover from injury, than those that are in any way weakened in vitality from lack of fertility or by neglect. Therefore, if a farmer and gardener gives special attention to the fertility and drainage of his land, procures the best seed, and by proper planting and cultivation secures vigorous plants from the start, and by proper care endeavours to keep them in this condition until the product is matured, he will have accomplished more in preventing loss from insect depredations than he would accomplish by the best remedies applied to half-starved, neglected plants.

Asparagus.

(Insects.)

COMMON ASPARAGUS BEETLE (*Crioceris asparagi*): A small, bright-colored beetle, about one-fourth of an inch in length; head, legs, and wing covers of a bright bluish-black color. There are six cream-colored markings on the back of the thorax, and margins of the wing covers are of a light reddish-brown.

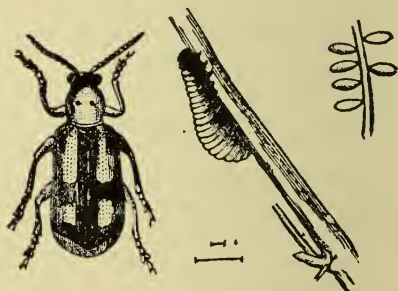
The brown-colored eggs are deposited on the stalks early in May, and from these hatch dull gray-colored larvæ. When the larvæ are full grown, they pass into the ground and change to pupæ, and about ten days later, emerge as adults.

The life-cycle, therefore, only lasts about a month. There are several broods each season, and we usually find eggs, grubs, and adults upon the plants from May until autumn. The winter is passed in the adult stage, under stones or beneath the bark of trees.

Remedies: Ridge the earth to protect the young shoots, and dust the plants every few days with air-slaked lime in the morning while the dew is on the plant; when the cutting season is over the plants should be sprayed with Paris green or arsenate of lead. This will kill both larvæ and adults. When practicable, turn the chickens into feed on the larvæ and beetles.



The Twelve-spotted Asparagus Beetle enlarged.



ASPARAGUS BEETLE.—(*Crioceris asparagi*, Linn.)

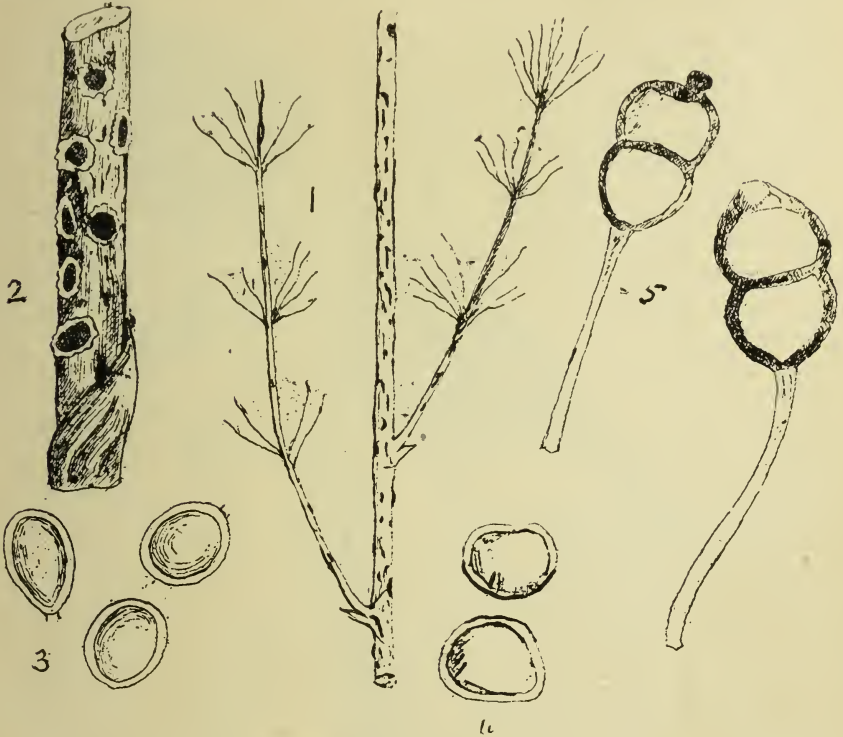
TWELVE-SPOTTED ASPARAGUS BEETLE (*Crioceris 12-punctata*):—The beetles are of a uniform reddish-orange color, with six black spots on each wing cover. They are about the same size as the Common Asparagus beetle. The habits of this beetle are much the same as the last.

Remedies: Same as for Common Asparagus beetle.

(Fungus).

RUST (*Puccinia asparagi*): Very numerous in some plantations. Numerous brown or black oval spore-producing postules break through

the skin of the stem. Three kinds of spores are produced, viz., cluster-cup spores, red summer spores, and black winter spores, all on the same plant.



ASPARAGUS RUST. 1, a diseased stem; 2, the cluster-cup stage on early plants; 3, spores of cluster-cup; 4, spores of summer stage (uredospores); 5, spores of the winter, or teliospore stage.

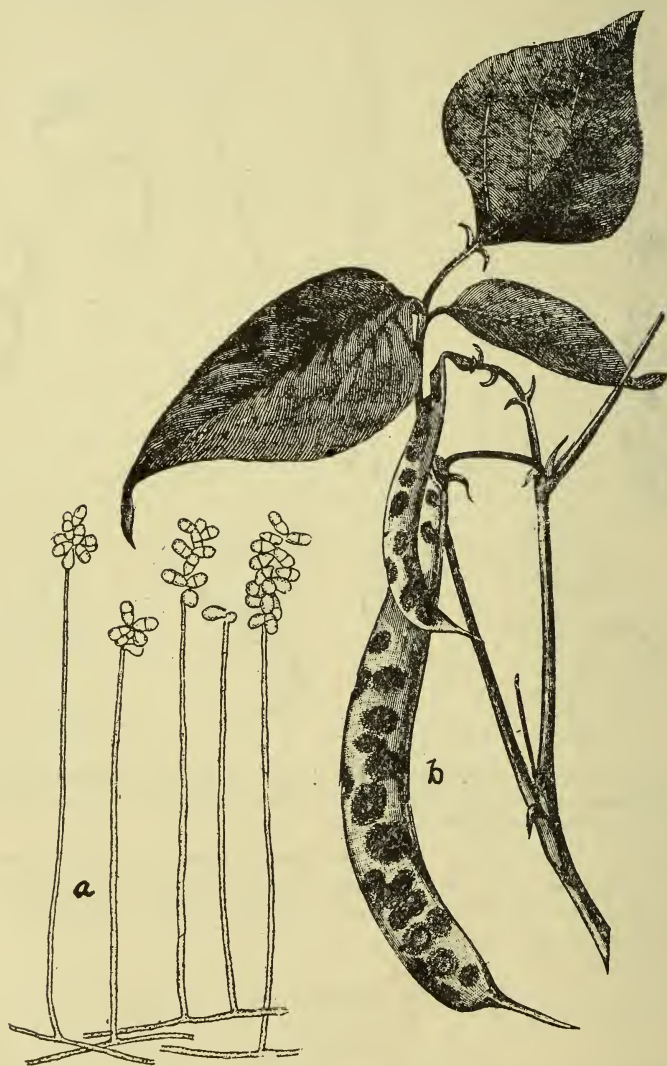
Remedies: Spray with resin-bordeaux from July to September at intervals of ten days or two weeks; dust liberally with flowers of sulphur; cut and burn the dead stems in autumn; plant resistant varieties, such as Palmetto and Argenteuil.

Beans.

(Fungi).

ANTHRACNOSE (*Collectotrichum lindemuthianum*): This disease occurs mainly on the pods, but sometimes on the leaves, as roundish, black, sunken spots, bordered with purple. The spores are produced at the ends of minute threads, massed together at points on the diseased spots.

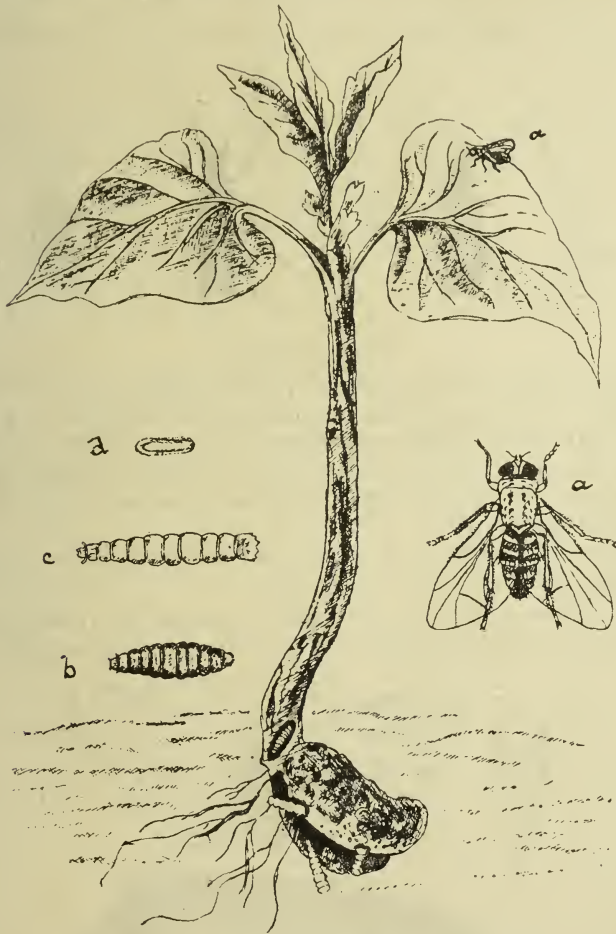
Remedies : Spray with Bordeaux at intervals of two weeks, beginning when the plants are quite small, and continuing into September or October. Soak the seed beans for two hours in formalin solution, made



PINK ROT ON BEAN ANTHRACNOSE. *a.* spores and spore-threads of the Pink Rot, showing the shape, and arrangement of the spores. (After Cornell Bull. 207); *b.* bean pods attacked by anthracnose.

by dissolving one-half pint in fifteen gallons of water. Destroy infected seedlings and leaves when first observed.

RUST (*Uromyces appendiculatus*): Bean rust is occasionally injurious on some varieties, and is readily recognized by the small brown or black pustules on both sides of the leaf.



BEAN FLY. *a.* adult flies; *b.* pupa case in ground; *c.* maggot; *d.* an egg. After Lugger.

Remedies: Burn the stalks and rubbish containing the spores, and plant varieties that are more or less rust-resistant.

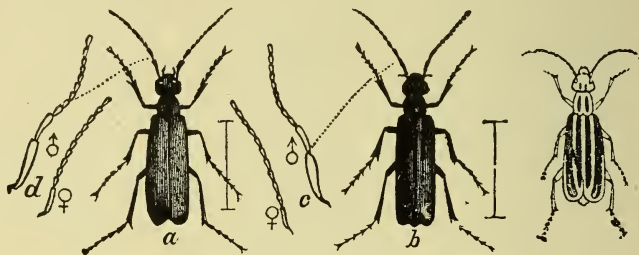
Beet.

(Insects).

OLD-FASHIONED POTATO BEETLE (*Epicauta vittata*): **ASH-GRAY BLISTER BEETLE** (*Macrobasis unicolor*), and **BLACK BLISTER BEETLE** (*Epicauta*

pennsylvanica: All three species of Blister beetles are injurious in the adult stage. They are about half an inch long, with long legs, and soft, flexible wing covers. The Old-Fashioned form is striped yellow and black. The Black and Gray forms look much alike, except for color.

In the larval stage these insects are beneficial, living upon the eggs of locusts.



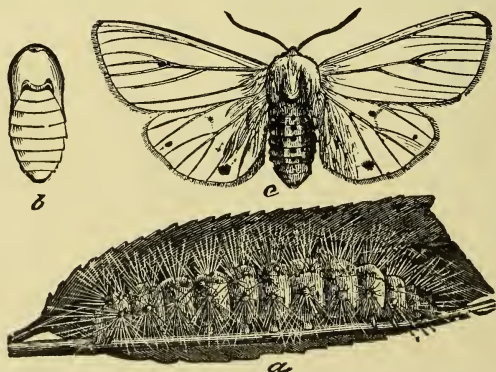
BLISTERING BEETLES.

Remedies: Spray with arsenical poisons. On account of their beneficial nature, it is not advisable to spray unless they are very abundant.

BEET-LEAF MINER (*Pegomya vicina*): The larvæ mine inside the leaf. At first the mines are small, but later, large blotches appear on the upper side of the leaf. The green tissue of the leaf is devoured, and the function of the leaf is destroyed.

Remedies: Gathering and destroying infected leaves; crushing the maggot inside the leaf.

WOOLLY-BEAR (*Spilosoma virginica*): Large caterpillars, about one and one-fourth inches in length. The color varies from pale yellow to



COMMON YELLOW BEAR.—(*Spilosoma virginica*) Fab.: a, caterpillar; b, pupa; c, adult. After Riley.

straw color. The adult is a snowy white moth, marked with a few black dots. The larvæ feeds on the leaves of the beet.

Remedies: Hand picking; Paris green in Bordeaux.

LEAF-HOPPERS (*Jassidae*): Small, elongated insects, usually pale green in color. They are very active and jump quickly when disturbed. They are provided with sharp sucking beaks, which extract the juices from the surface of the leaf. When present in large numbers, they cause a gradual decline of the plant, and in some cases death.

They pass the winter in the adult state, under boards, stones, leaves, etc.

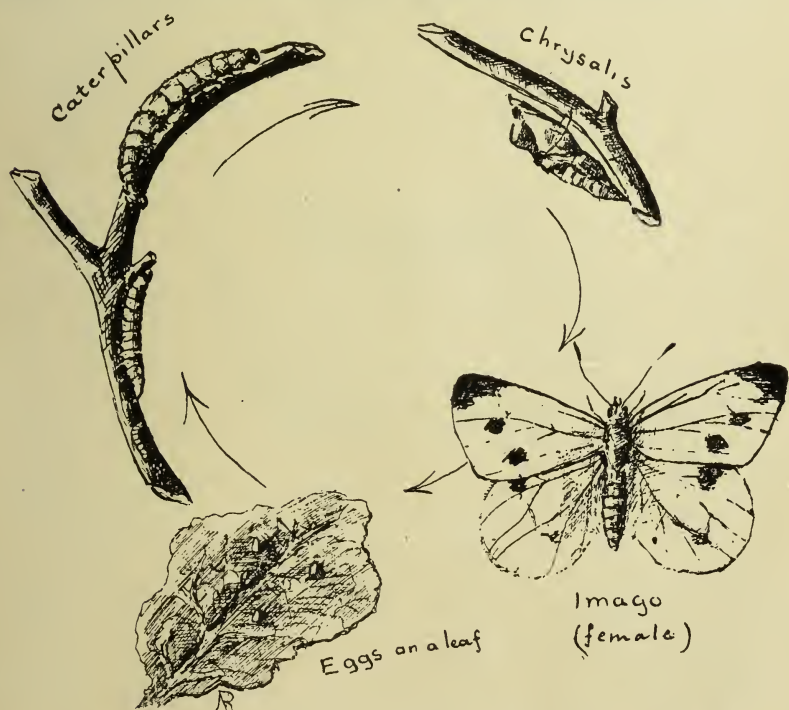
Remedies : Collect and burn all rubbish before winter sets in.

Contact poisons have not proved very satisfactory.

Cabbage.

(Insects).

CABBAGE-WORM (*Pieris Rapæ*): The common green worm of the cabbage. It is about the same color of green as the cabbage leaf. Its



CABBAGE BUTTERFLY. The four stages in the butterfly's life history are represented : eggs, larvæ or caterpillars, chrysalis, and wings.

body is covered with fine short hairs, and when mature it is about one and a half inches in length. The adult is the common white Cabbage butterfly.

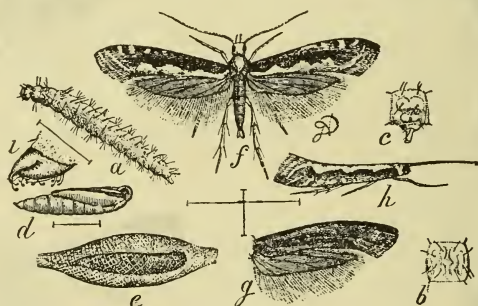
Remedies : Spray with Paris green, using one pound of Paris green to every 100 gallons of water, and adding a little hard or soft soap to prevent the liquid rolling off the cabbage leaves; hellebore dusted over the cabbage leaves in early morning.

Hellebore is poisonous to insects, although harmless to man. It is more expensive than Paris green.

CABBAGE-ROOT MAGGOT (*Phorbia brassicæ*): This pest is well known to the vegetable growers of Ontario. The eggs are laid by a small fly in the soil near the root of the cabbage. In two or three days the eggs hatch, and the small white maggots find their way to the root of the cabbage or cauliflower. The young maggot tunnels into the root and the affected plant soon withers and dies.

The winter is passed, for the most part, in the pupal condition.

Remedies : Carbolic acid emulsion (diluted about thirty times with water) using one-half teacupful to each plant and pouring it about the root with a sprinkler the day after setting and repeated every ten days, until the end of May; tobacco dust placed around the stem of the plant; pads of tarred paper about 2 and 2½ inches in diameter, placed about the plants shortly after setting time; destroy diseased plants.

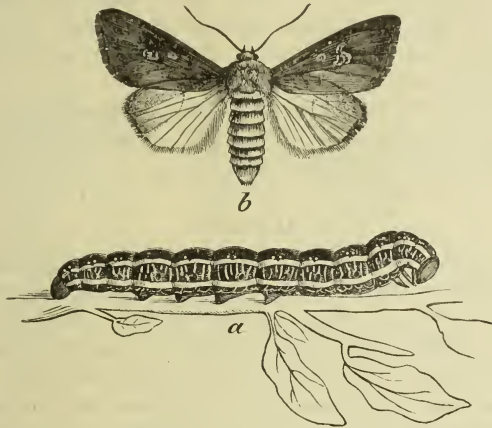


THE DIAMOND-BACK MOTH : *a*, caterpillar ; *d*, pupa ; *e*, cocoon ; *f*, moth—enlarged.

DIAMOND BACK MOTH (*Plutella maculipennis*): Small green-colored caterpillars, about three-eighths of an inch in length. When disturbed they wriggle about and fall to the ground. Their presence is easily detected by the numerous small holes eaten through the leaf. The larval stage lasts about a month, and then they spin small cocoons on the under side of the leaf. About two weeks later the adult moth emerges. There are, at least, two broods in a season.

Remedies : Dust or spray the infected plants with the usual Paris green mixtures or solutions, as for Cabbage-worm. Induce vigorous growth by light dressings of nitrate of soda.

ZEBRA CATERPILLAR (*Mamestra picta*): Very bright-colored caterpillars, velvety black on the back, and with bright yellow stripes on each side of the body. They attack many plants of the Cruciferæ family, including Turnip, Rape, Cabbage, and Cauliflower. They seldom occur in such numbers as to do much injury.



ZEBRA CATERPILLAR (*Mamestra picta*, Harris.)

Remedies : Dust plants with Paris green and some dry powder, or spray with Paris green solution.

CUTWORMS : The cutworms are large, dark-colored insects, about one and a quarter to one and a-half inches in length. They are smooth, naked, and present a greasy looking appearance. When disturbed they curl up



THE CABBAGE APHIS male; 3 and 4, wingless female—2 and 4 enlarged.

CABBAGE MAGGOT ; 1, maggot; 2, 3, pupa case; 4, fly—1, 3 and 4 enlarged.

at both ends. Some confine their ravages to the ground, and are known as ground cutworms. Others, which defoliate trees, are known as "Climbing cutworms." The pupal stage is passed in the ground, and the moths appear in midsummer.

They cut off the young plants just below the surface of the soil.

Remedies: Sprinkle poisoned bait between the rows (prepared according to the formula), but keep poultry away at such times. The cut-worms always bury themselves in the soil before they die.

APHIS (*Aphis brassicæ*): Minute, soft-bodied insects, covered with a coat of fine, waxy powder. They have sucking mouth parts, and extract the juices from beneath the surface of the leaf. They multiply very rapidly, and about mid-summer the under surface of the leaves becomes literally covered by them.

Remedies: Spray with whale-oil soap, prepared by dissolving one pound of the soap in from four to six gallons of the water, and apply as in the case of kerosene emulsion.

(Fungi).

CLUB ROOT (*Plasmiodiophora brassicæ*): This disease is caused by a slime-fungus, and is characterized by irregular enlargements or galls on the roots, and by the spindling nature of the affected cabbage, which makes little or no head. The cells of the galls are abnormally large, and, before maturity, contain a grey or brown granular mass of protoplasm. At maturity this mass is converted into spores, which later are set free in the soil. Naked moving bits of protoplasm escape from the spores, and it is believed that they enter the plants by the root-hairs. Turnips, radish, mustard, shepherd's purse, and other members of the Cruciferæ are liable to this disease.

Treatment: As the spores may remain dormant for several years in the soil, infected fields should not be used for the same crop for several years; cabbage on soils rich in lime suffer but little from Club-Root, hence it is advisable to apply a coating of slaked lime (75 bushels to the acre); weeds, such as mustard and Shepherd's Purse, should be looked after carefully; on no account put Club-root refuse on the manure or compost heap, but burn it; "manure from cows fed with clubbed roots will easily infect crops."

BLACK ROT (*Pseudomonas campestris*): This is a bacterial disease of cabbage, cauliflower, rape, and Swede turnip, and spreads rapidly in low, damp soils during rainy, moist weather. The lower leaves are usually first attacked, where the veins turn black and the leaves wilt.

Treatment: Remove and destroy diseased plants; avoid low, damp soils, and rotate the crops.

SOFT ROT (*Bacillus oleraceæ*), is another bacterial disease of cabbage and cauliflower. (See O.A.C. Bulletin 136.)

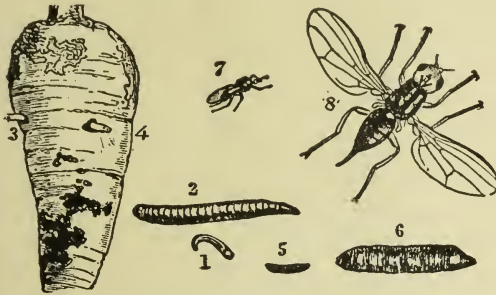
Carrots.

(Insects).

THE CARROT RUST FLY (*Psila rosæ*): Semi-transparent, yellowish maggots, about one-fourth of an inch long, blunt at the tail end, but

tapering toward the head; frequently injure the roots of carrots. The mature insects are a species of small fly.

The leaves of the young carrots turn reddish, and the roots become minutely furrowed and blotched with rusty patches. The carrots when stored for winter use, although sometimes not showing much injury on the outside, may be found to be perforated in every direction by dirty brown burrows.



CARROT RUST-FLY—natural size (1, 5, 7), and enlarged (2, 6, 8).

Remedies : Sow late to escape the flies; spray with kerosene emulsion solution (one part of the ordinary emulsion to nine of water); dust rows with lime, land plaster, or ashes, to which a little coal-oil has been mixed. One application a week should be made through June and into July. Rotation of crops.

Celery.

(Insects).

CELERY CATERPILLAR (*Papilio asterias*): The adult is a very handsome swallow-tailed butterfly. The larva when full-grown is about one and one-fourth inches long; is pale-green, and marked cross-wise with yellow and black lines. Just behind the head is a pair of horn-like structures, which can emit an unpleasant odor.

Remedy : Hand-picking is usually sufficient to control the caterpillars.

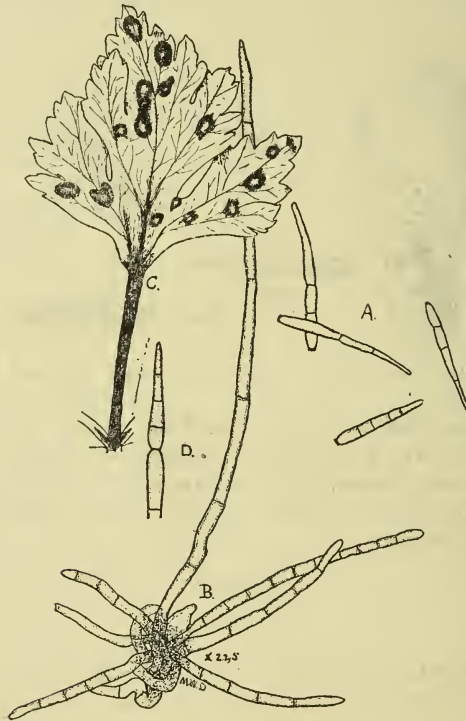
(Fungi).

LEAF BLIGHT (*Cercospora apii*): This fungus disease is sometimes known as "rust," and appears on the leaves first as light spots, which later become brown, and finally yellow. The spots soon increase in size and become irregular in shape, and the plants are seriously injured. The spores can be readily found on the diseased areas.

Remedies : Spray with Bordeaux while the young plants are in the frames before transplanting, and repeat at intervals of ten days. It is

recommended to use the Ammoniacal-copper carbonate solution in the later sprayings.

LEAF SPOT (*Septoria petroselini*, var *apii*): Brown spots, studded with minute black spots, appear on the leaves.



CELERY BLIGHT. (*Cercospora Apii*).—A, spores through the agency of which the disease spreads; B, tuft of aerial protruding through a breathing-pore of a leaf; C, a diseased leaf, showing the brown.

Remedies: Same as for leaf blight above.

Corn.

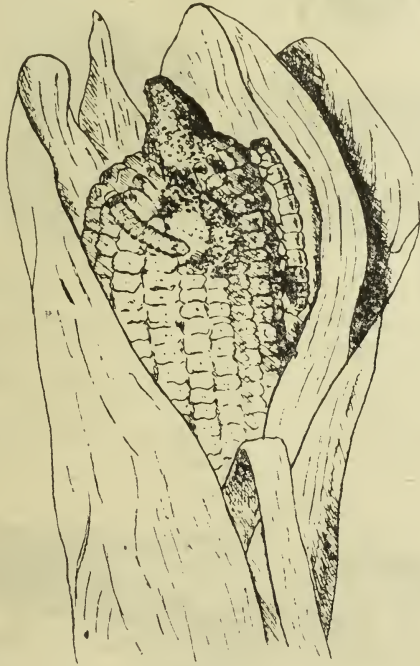
(Insects).

CORN-STALK BORER (*Papaipema nitela*): The larvæ which belong to the Cutworms bore into the stalks of the young corn plant. The leaves turn yellow, and the stalks die prematurely. It is a general feeder, and attacks potatoes, tomatoes, and many species of weed.

Remedy: Destroy the diseased shoots.

JUNE BEETLE or WHITE GRUB (*Lachnosterna fusca*): The larva is a large, soft, white grub, about an inch and a half long, and usually curled at the postern end. The pupa stage is passed in the ground. The adult is a large, plump, brown beetle, known as the June "bug." It takes two or three years to develop, and is sometimes very destructive to garden crops.

Remedies : Late fall plowing destroys the pupæ, and exposes them to their enemies and the weather; rotation of crops prevents the development of the insect; shaking the adults from trees upon sheets.



CORN WORM. An ear of corn affected by corn worm. Caterpillars are very variable in their markings.

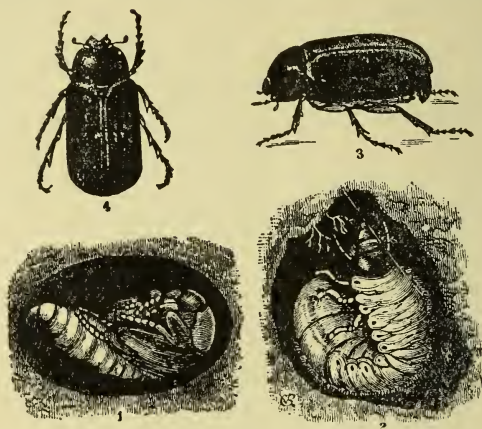
CORN EAR-WORM or COTTON BOLL-WORM (*Heliothis armiger*): The larvæ are striped, and may be greenish or reddish in color, and when full-grown about one and one-fourth inches long. The larvæ feed on the ears of the sweet corn, and the affected ears are unsightly and unfit for table use.

It has never been very troublesome to Ontario corn-growers. It also feeds on the fruit of the Tomato.

Remedy : Late fall plowing destroys the pupæ.

GRASSHOPPERS AND LOCUSTS: Large jumping insects, with biting mouth parts. They feed on asparagus, beet, sweet corn, and many other kinds of garden plants.

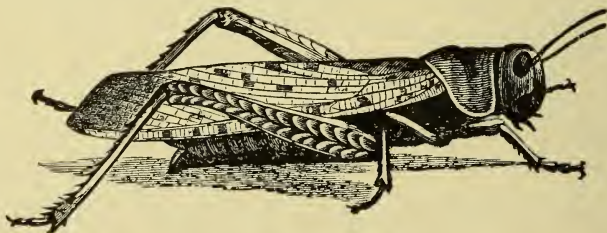
Remedy: Spray with Paris green solution, arsenical Bordeaux, use poison bait.



MAY BEETLE. *Lachnosterna fusca*, Fröhl. From Riley.

WIREWORM OR CLICK BEETLE: Slender, yellowish-brown worms, with six legs on the front segments of the body. They are hard and wire-like, and when full grown are about an inch long. They require from three to five years to pass through their life-stages.

The adults are dark gray click beetles, for when they are placed on their backs they turn over with a click.



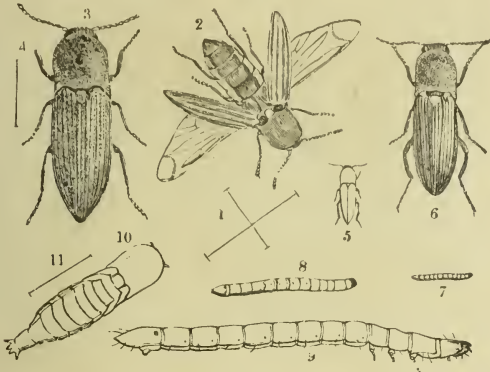
A GRASSHOPPER OR LOCUST.

Remedies: We have no satisfactory remedy for wire-worms. Poisoned baits, such as sliced potato and clover soaked in Paris green, placed under boards, have given the best results for garden plants; rotation of crops, and late plowing are helpful.

(Fungi).

SMUT (*Ustilago maydis*): Sometimes the cobs of corn become greatly enlarged, and the leaves and staminate tassels have tumor-like growths.

These are produced by a fungus called Corn Smut. The growths are filled with black spores, which rest over winter, germinate in the spring, and produce multitudes of secondary spores. These are carried by the wind to new corn plants, which become infected. It has been shown that only young parts of the corn plant can be infected and attacked.



WIREWORMS (7, 8, 9) ; pupa (10)—enlarged ; click-beetles (5—natural size ; 2, 3, 6—enlarged). (Curtis.)

Treatment : Avoid fresh manure ; remove and burn all the smut growths as soon as discovered. Seed treatment is not effective.

RUST (*Puccinia sorghi*) : Reddish or blackish elongated pustles occur on both sides of the leaf. The injury is not often serious.

Cucumber.

(Insects).

STRIPED CUCUMBER-BEETLE (*Diabrotica vittata*) : This beetle is well known to the vegetable grower. It is light yellow, with four black lines down the back, and is a little more than two-fifths of an inch in length. The eggs are laid on the stems just below the surface, and when hatched bore into the stem or root. The winter is passed in the adult stage, under any rubbish which will afford shelter. In the spring, as soon as the young cucumbers appear above the ground, the beetles leave their hibernating quarters and devour the foliage of the seedlings. It feeds also upon the squash and melon, and is a very difficult insect to overcome.

Remedies : Spray with arsenical Bordeaux as soon as plants appear above ground, and repeat ten days later ; dust the young plants with Paris green, and land plaster, ashes or lime (one to fifty), or with dry slaked lime and sulphur, and repeat ten days later ; keep the young vines covered with cheese-cloth, fixed to frames ; clean up refuse in the fall.

SQUASH-BUG (*Anasa tristis*) : The adult insect is a rusty-brown, flat bug, yellow on the under side. It is about three-fifths of an inch in length

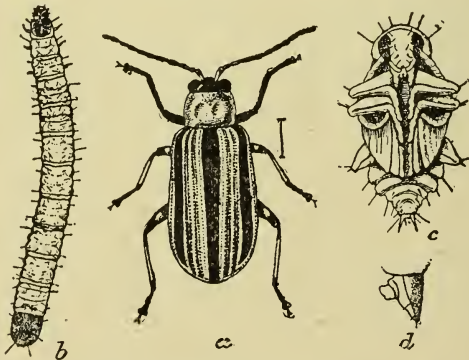
and has a very offensive odor. It winters in the adult form underneath leaves, boards, etc. The eggs are reddish-brown, and are laid on the under side of the leaves.

Remedies: Hand-pick the insects morning and evening, when they are least active; collect and destroy the egg masses; spray the vines thoroughly with kerosene emulsion or soap solution to kill the young



Portion of a cucumber vine showing natural infection with *B. tracheiphilus*. Note the wilted appearance of the leaves.

bugs; protect the young plants with cheese-cloth screens; trap with shingles and pieces of board, under which the bugs will gather, or with early squash plants.



STRIPED CUCUMBER BEETLE (*Diabrotica vittata*).
From Chittenden.

TWELVE-SPOTTED CUCUMBER BEETLE (*Diabrotica 12-punctata*): A greenish-yellow beetle, with twelve black spots on its wing covers. It.

is about the same size as the striped cucumber beetle, and attacks the same plant.

Remedies : Same as for Striped Cucumber Beetle.

(Fungi).

DOWNY MILDEW (*Plasmopara cubensis*) : This disease is also common on musk melons. Large yellow spots appear on the leaves, and cause them to shrivel up. The disease is most serious during muggy weather. The spores are borne on peculiar stalks on the under side of the leaf, and are borne to unaffected leaves by wind. As the body of the fungus lives within the tissues of the leaf, it is impossible to effect a cure after the leaf is inoculated.

Treatment : Spray with Bordeaux every ten days after the middle of July, giving attention to the under sides of the leaves. This treatment will at least keep the fungus in check.

WILT (*Bacillus tracheiphilus*) : is a bacterial disease of cucumber, squash, and pumpkin. The leaves of affected vines suddenly wilt, and in a few days shrivel and turn brown. The disease progresses in the vine in the direction of growth, and kills the leaves in succession.

Lettuce.

(Fungi).

DOWNY MILDEW (*Bremia lactucae*) : Greyish, mouldy areas occur on the under side of the diseased leaves, which show yellowish-brown patches. This fungus thrives well in moist situations. The spores are borne on peculiar branching stalks, constituting the mould.

Treatment : Care in draining, watering, and ventilating will do much to control this disease.

THE GREY MOULD (*Botrytis vulgaris*) : This is very common in green-houses. It causes a rotting of the leaves, upon which it appears as a greyish mould. In rotting leaves are found also minute black bodies (sclerotia), which carry a leaf-rot disease, (*Sclerotinia libertiana*) called the Drop, over from one crop to another. It may be that the Gray Mould is the summer stage of the Drop disease.

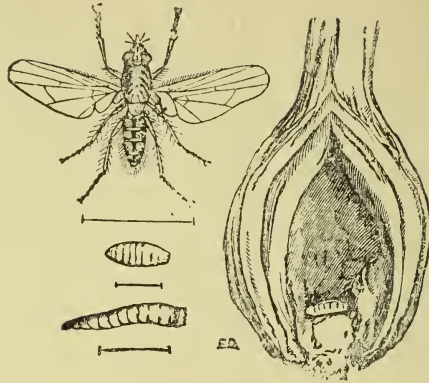
Treatment : Care in draining and ventilation; sterilize the soil with hot water, or add a coating of sterilized sand or earth; apply coatings of coal ashes, or sulphur and charcoal.

Onion.

(Insects).

ONION-MAGGOT (*Phorbia ceparum*) : The adult is a small fly, about half the size of the common house fly. The eggs are laid on the young plants in early spring, and hatch in a few days, when the larvæ burrow into the bulbs. When full-grown, they pass into the soil and become

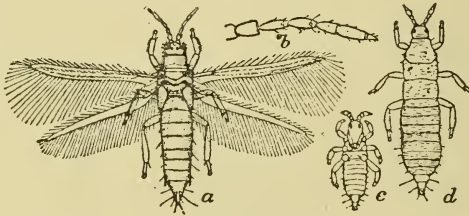
pupæ, and the adult flies emerge a little later. There are several broods in a season.



ONION MAGGOT.

Remedies : Crude Carbolic Emulsion, as for the Cabbage root maggot, sprinkle along the rows over the plants once a week ; horse-hoe a furrow away from the plants, in which nitrate of soda is distributed, and cover with earth ; remove diseased plants, and destroy maggots ; white hellebore dusted along the rows once a week from the time the young plants appear above ground ; fresh gas lime broadcasted between rows of onions at the rate of two hundred weight to the acre.

THRIPS (*Thrips tabaci*) : Very minute insects, about one-twenty-fifth of an inch in length, of a pale yellow color, with darker-colored wings.



ONION THRIPS (*Thrips tabaci*). a. adult female ; b. antenna of same ; c. young larva or nymph ; d. full grown larva. All enlarged.

(After Howard, Division of Entomology, U.S. Dept. of Agriculture, Yearbook for 1898.)

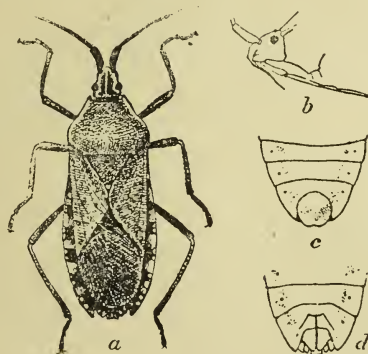
They occur in very large numbers, and the injury is visible in the form of small yellow spots, increasing in size until the tips of the leaves become yellow or brown ; the whole stalk finally having a whitish appearance, and, if the weather is wet, the leaves decay.

Remedy : Spray with kerosene emulsion, used at the rate of one part of the emulsion to ten of water.

(Fungi).

DOWNY MILDEW (*Peronospora schleidenii*): This is a common disease of onions. The leaf first shows yellow patches, covered with a greyish mould. Later, the patches increase in size and numbers, and the leaf shrivels and dies. Two kinds of spores are produced, viz., thin-walled summer spores, on the minute branched stalks forming the greyish mould, and thick-walled winter spores (oospores), in the tissues of the leaves killed by the fungus. The summer spores are scattered by the wind during summer, and are the agents in the spread of the disease.

Treatment: Rotation of crops is necessary, especially when winter spores are in the infected soil; removal and burning of diseased plants; spray with Bordeaux or potassium sulphide (1 ounce to 2 gallons of water); dusting the plants with powdered quicklime and sulphur (2 to 1).



TRUE SQUASH BUG. (*Anasa tristis*, De G.). *a.* mature female; *b.* side view of head, showing beak; *c.* abdominal segments of male; *d.* same of female;—*a.* twice natural size; *b., c., d.*, slightly more enlarged. After Chittenden, Div. of Entomology, Dep. of Agriculture.

SMUT (*Urocystis Cepulæ*): This disease is often troublesome to control. Early in the season leaves of onions may show the black smut masses arranged more or less in lines. The onions are only infected during their seeding stage from the spores, either attached to the seed or lying in the soil, hence the danger of planting onions in smut-infested soil.

Treatment: Destroy and burn diseased plants; when soil is smut-infested grow seedlings in smut-free soil, then transplant; in infested soil "apply in the drills, per acre, one hundred pounds of sulphur thoroughly mixed with fifty pounds of air-slaked lime; sprinkle seed with formalin solution (1 pound to 30 gallons of water) to kill the attached spores."

BLACK MOULD (*Macrosporium parasiticum*): This fungus is usually found associated with the Downy Mildew, but it is supposed to be respon-

sible for injury to the leaves. The diseased areas are covered with a thick black growth of the fungus. The spores are many-celled and dusky-colored.

Treatment: Spray with Bordeaux.

Garden Peas.

(Insects).

PEE-WEEVIL (*Bruchus pisorum*): The eggs are laid on the young pods as soon as they are formed. The larvæ when hatched bore into the pod and destroy the seeds. The winter is passed in the adult stage.

Remedies: Sow only seed peas that have been fumigated with carbon bisulphide.



PEA WEEVIL.—(a) The grub ;
(b) the pupa, under surface ;
(c) the pupa, upper surface ;
(d) the adult weevil.

PEA MOTH.—(a) A full grown "worm" or caterpillar (enlarged); (b) adult moth with wings expanded (enlarged); (c) adult moth with wings closed; (d) a group of five peas injured by the caterpillar of the pea moth.

PEA-APHIS (*Nectarophora pisi*): It is a large, soft-bodied, green louse, either with or without wings. Besides the Pea, it feeds on clover, vetches, and, probably, many other leguminous plants.

Remedies: Spray with kerosene emulsion or with whale oil soap wash.

PEA MOTH (*Semasia nigricana*): Hairy white caterpillars—when full-grown nearly one-half an inch long. The small adult moth lays its eggs on the pods in the latter part of June or early in July. The caterpillar attacks the peas and renders them unfit for table use.

Remedies: Rotation of crops, sow early to escape the moth.

(Fungi).

PEA MILDEW (*Erysiphe martii*): Sometimes leaves and vines show a fine growth of mould-like threads, followed later by many small dark bodies which bear the resting spores. The summer spores are borne in erect chains on the fine white threads. Affected leaves are small, the vines are weak, and the pods are small and shrivelled.

Treatment: Spray with Bordeaux when the Mildew makes its appearance, but it is not often necessary to resort to this treatment.

LEAF-SPOT (*Ascochyta pisi*): The lower leaves show yellow blotches, and soon fall off. Occasionally the vines and fruit are attacked. The spores are small, and are borne in little sacs on the blotches.

Potato.

(Insects).

COLORADO POTATO BEETLE (*Septinotarsa 10-lineata*): This very familiar pest spends the winter in the ground. They leave their hibernating quarters about the middle of May, and commence mating at once. The eggs are laid on the under surface of the leaf, and hatch a few days later. When full-grown, the larvæ pass down to the ground, where they change to orange-colored pupæ, about three inches below the surface. There are three broods in a season.

Remedies: Spray with Paris green-Bordeaux (formula 4-4-40½) or the arsenate-of-lead-Bordeaux, when plants are 2 to 4 inches high, and repeat every ten days or two weeks, and after rains.

FLEA-BEETLE (*Epitrix cucumeris*): Very small black beetle, about one-sixteenth of an inch in length. The hind legs are very highly developed, and fitted for leaping. They riddle the leaves of the potato and tomato with little round holes. It is through these holes that the spores of the Early Blight enters the plant.

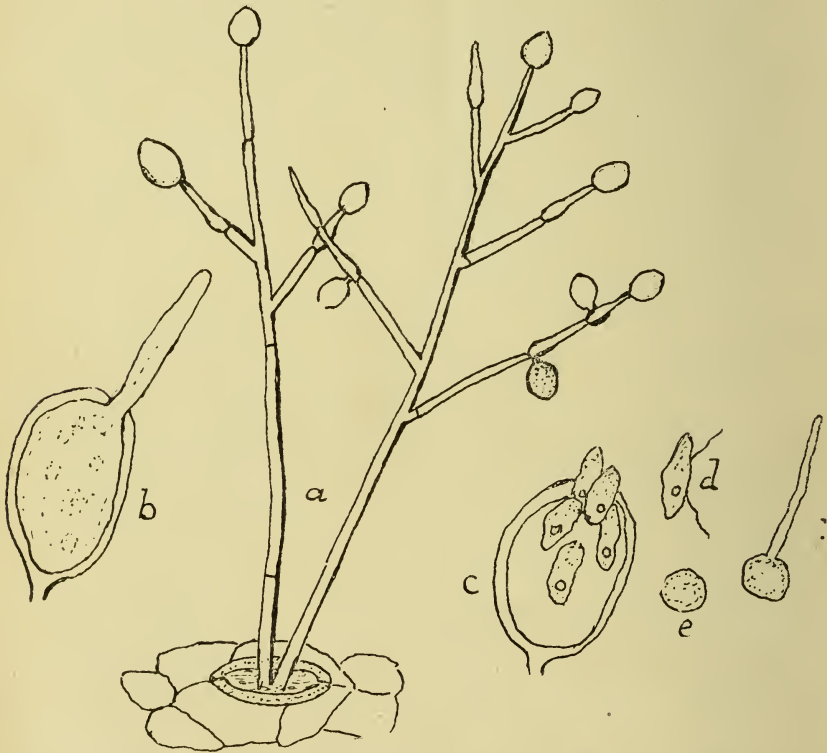
Remedies: Spraying with arsenical Bordeaux; destroy hibernating quarters by clean culture.

STALK-WEEVIL (*Trichobaris trinotata*): Small, white, legless, grubs, about one-fifth of an inch long. They bore in the stem of the potato and cause the leaves to turn yellow and the stem to die prematurely. The grubs change to pupæ within the stems, and a little later the adults emerge from their pupæ and remain in the stalks until the following spring.

Remedies : Gather and burn all the stalks in the fall, and the beetles will be destroyed.

APHIS (*Aphis* sp.): Small, green, soft-bodied plant lice, about one-sixteenth of an inch long. They have sucking mouth parts, and are usually found on the under side of the leaves. They extract the juices from the leaf, causing the leaves to curl up.

Remedies : Tobacco water or dilute whale oil soap in the Paris green-Bordeaux.



THE FRUITING ORGANS OF LATE BLIGHT : (a) The branching stalks which issue from a breathing pore of the leaf, and the spores ; (b) a simple spore or conidium germinating ; (c) a sporangium with contained zoospores ; (d) a zoospore with its two whips ; (e) a zoospore after losing its whips ; (f) a zoospore germinating.

FOUR-LINED LEAF-BUG (*Poecilopsus lineatus*): A yellow sucking insect, with its wing covers marked with black. It is a little more than one-fourth of an inch in length, and feeds on the foliage of many garden plants. The affected leaves turn brown and curl.

Remedies : Spray the young bugs with kerosene emulsion; add a little whale oil soap to the Bordeaux.

(Fungi).

LATE BLIGHT OR DOWNY MILDEW (*Phytophthora infestans*): This fungus disease is often very destructive in late summer to the potato crop. The margins of the leaves are usually the first portions to become diseased, probably because in periods of excessive moisture the edges are kept longer moist than the inner parts. There is a sharp line of demarcation between the affected and the unaffected areas; and in moist, warm



EARLY BLIGHT.

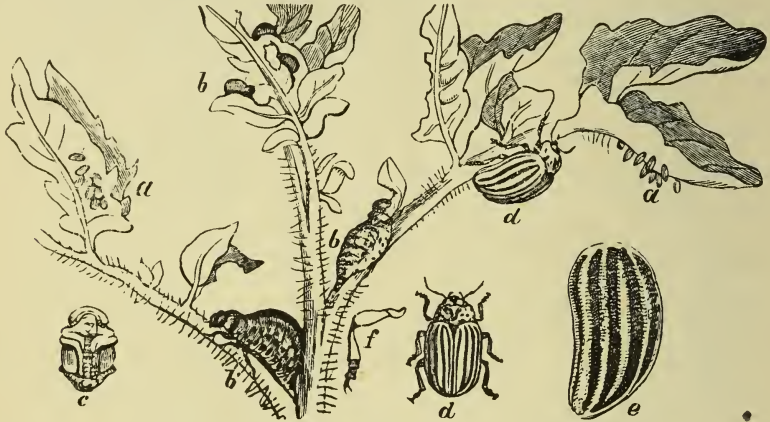


LATE BLIGHT.

weather, when the affected areas are enlarging rapidly, there is between the two areas a narrow whitish ring of mildew, which is producing spores in large numbers. The diseased leaves first turn brown, then darker, and finally black. Complete decay of the leaves soon occurs, accompanied by an offensive, yet characteristic, odor.

It is usually supposed that the fungus attacks the tubers as well as the stalks and leaves, producing a brown rot, but the mode of infection

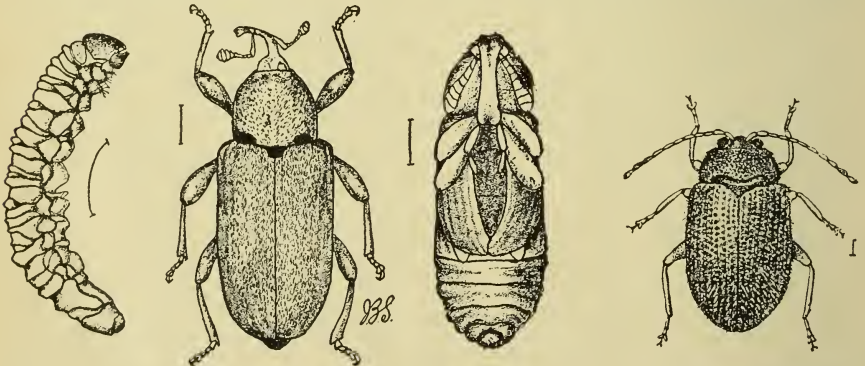
has not been definitely proven. As no winter spores have yet been observed, it is believed that the threads of the fungus live over winter in the affected dormant tubers, and from these the following season make their way back to the stalks and leaves. It is probable that the soft rot of potatoes is mainly of bacterial origin.



COLORADO POTATO BEETLE (*Doryphora decem-lineata*, Say.)

Treatment: Spray with Bordeaux, every two weeks, beginning about July 10th, and continuing well into September; plant the more resistant varieties, and avoid wet soil, if possible.

EARLY BLIGHT (*Macrosporium solani*): Attacks early potatoes. The plants ripen prematurely, and the tubers are small. The affected leaves become gradually discolored; have many yellow areas, which are small



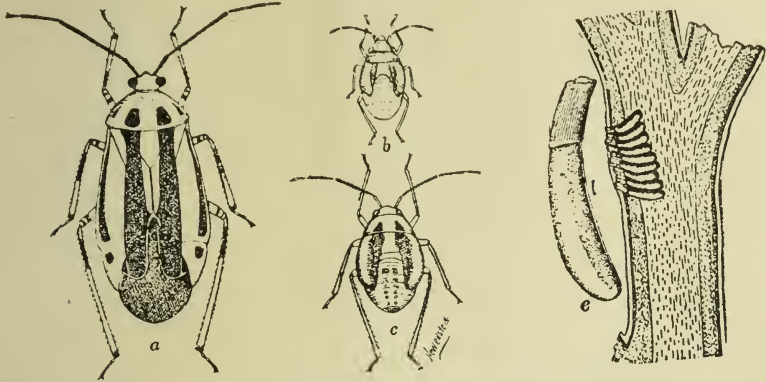
POTATO STALK WEEVIL. Larva, beetle, and pupa—enlarged.

CUCUMBER AND POTATO FLEA-BEETLE.

and circular, except where several have run together; and have a strong tendency to curl. During the later stages of the disease the leaves gradually become brown and shrivelled; and the stems become yellowish-

brown and dry. It is believed that flea-beetles are responsible to some extent for the spread of the disease.

Treatment: Spray with Bordeaux and Paris green when the plants are three or four inches high, and repeat every two weeks through June and July. This treatment will control both the fungus and the flea-beetles.



FOUR-LINED LEAF BUG. (*Pæcilopsus lineatus*, Fab). a. adult; b., c. immature. Lagger. Eggs after Slingerland.

DRY ROT (*Fusarium oxysporum*): This disease produces a wilt of the stalks, and a rot of the tuber, characterized by a blackening of the ring of fibres and an end-rot. These injuries usually follow the blight; and the rotting is frequently in market potatoes, which may appear quite sound on the outside, but on cutting them open show black or brown spots or parts of rings.

Treatment: By spraying to prevent Blight, and selecting seed potatoes carefully, the injuries may be reduced.

WET ROT (*Bacillus* sp.): A common bacterial disease of potatoes, producing soft rot.

Radish.

(Insects.)

RADISH-MAGGOT (*Phorbia brassicæ*): These are the same maggots that work in Cabbage roots, and for further information concerning appearance and life-history of this insect, see insects affecting the cabbage.

Remedies: Sprinkle carbolic acid emulsion solution along the rows about once a week; light frames, two or three feet high, enclosed on all sides with cheese cloth, placed over the beds; dust white hellebore along the rows once a week; slight applications of nitrate of soda between the rows. (See Onion Maggot.)

(Fungi).

WHITE RUST (*Albugo candida*): Small, white blisters form on the under side of the leaves; and when these blisters rupture the summer spores are set free as a white powder. Winter spores are also formed within the leaf, and are liberated the following spring on the decay of the tissues. This fungous disease, although not a serious one, is quite common, and is found on cress, turnip, cabbage, Shepherd's Purse, and mustard.

Treatment: Destroy all diseased plants.

DOWNY MILDEW (*Peronospora parasitica*): This disease occurs also on cabbage, turnip, and other Cruciferous plants. It is found along with the white Rust as whitish, filmy patches on the under surface of the leaf and discolored brownish-yellow spots on the upper surface. Both summer and winter spores are formed, the latter within the leaf.

Treatment: Destroy all diseased plants.

DAMPING-OFF (*Pythium debaryanum*): Damping-Off is a very common disease, affecting the seedling stage of many plants, more especially Cruciferous plants, such as radish, mustard, cabbage, and stock. The affected parts topple over near the surface of the soil, and the stem at that point is shrivelled, weak and black. The disease spreads rapidly in moist situations, and much difficulty is experienced sometimes in growing the plants. Besides summer spores, resting spores are formed, which may remain dormant in the soil for many months.

Treatment: Avoid excessive watering of seed-bed, and sow thinly; avoid shade for the seed-bed; burn all diseased plants; never use soil that has borne plants diseased with *Damping-Off*; in gardens bury the upper layers deeply with the plow.

Squash.

(See insects affecting the Cucumber.)

Tomato.

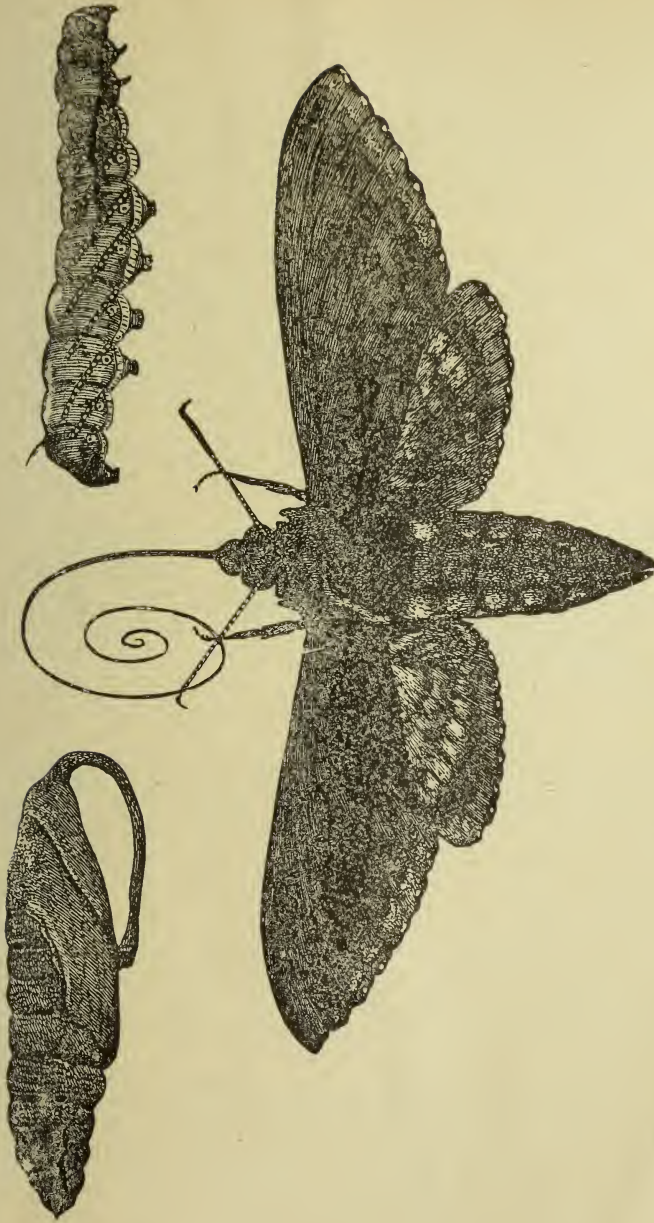
(Insects.)

TOMATO-WORM (*Phlegethontius celeus*): The larva is about three inches long and has a horn-like structure on the last segment. The general color is light green with oblique whitish bands on each side. The eggs are deposited on the leaves of the tomato and potato. The pupa has a long tongue case, and is passed in the ground.

Remedy: Hand picking, spray with arsenical poisons.

CUTWORMS: For description of habits and life-history, see insects affecting the cabbage.

Remedy: Poisoned bran, sweetened with a little molasses and made into moist balls the size of a plum. Do not use this treatment, unless stock and poultry are excluded.



TOMATO WORM (*Sphinx quinquemaculata*, Hub.)

CORN-EAR WORM: Sometimes found feeding on the fruit of tomato. (For description of larva, see insects affecting corn.)

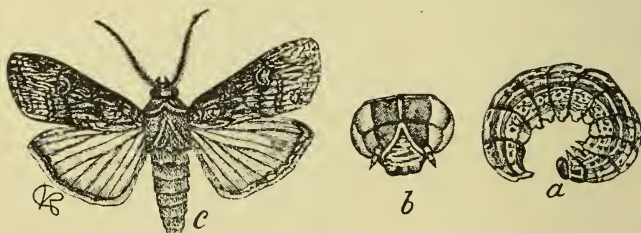
FLEA-BEETLES (*Epitrix cucumeris*): This is the same flea-beetle that causes injury to the potato. It riddles the leaves of the tomato with little holes, and injures the function of the leaf.

For further description of this pest and treatment, see insects affecting the potato.

(Fungi.)

BLACK ROT (*Macrosporium tomato*): This fungus produces roundish, black velvety areas on the fruit of the tomato. The spores are many-celled, and sooty-colored, and are borne on threads covering the diseased spots. Sometimes the leaves and stems are also affected.

Treatment: Spray with Bordeaux, beginning when the flowers open, and repeat at intervals of ten days or two weeks.



CUT WORMS (*Agrotis ypsilon*). After Riley.

BLIGHT (*Bacillus solanacearum*): This is a bacterial disease and causes the death of the leaves. The bundles of the potatoes and stems become brown or black. The disease is apparently spread to some extent by insects.

Treatment: Keep potato beetles and flea-beetles in check with Bordeaux and Paris green.

LEAF SPOT (*Septoria lycopersici*): Attacks the leaves, stem, and sometimes the fruit. Angular spots containing minute black fruits appear on the leaves and do considerable injury.

Treatment: Spray with Bordeaux a week after transplanting, and again at intervals of two weeks.

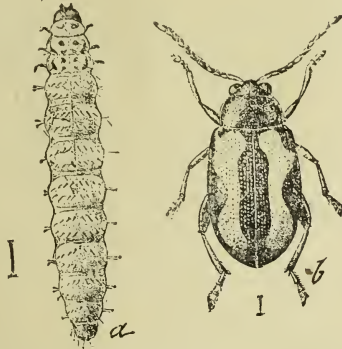
SCAB (*Cladosporium fulvum*): Olive-brown, felt-like areas occur on the under side of the leaves and brown discolorations on the upper surface. In severe cases the leaves turn black, shrivel up, and die. Tawny-colored, two-celled spores are produced on the clustered stalks of the fungus of the under surface.

Treatment: Spray with Bordeaux early and repeat at intervals of ten days or two weeks.

Turnip.

(Insects.)

TURNIP FLEA-BEETLE (*Phyllotreta vittata*): A small, shining, black beetle, with a yellowish, wavy stripe on each wing cover, and about 1/16 of an inch in length. It feeds upon the leaves, not only of the radish, but also of the turnip, cabbage, and many other Cruciferous plants.



TURNIP FLEA BEEBLE. (Enlarged
8 times.)

Remedies : Spray with arsenical poisons; Paris green, mixed with 25 parts of flour, dusted on the plants while the dew is on; Bordeaux acts as a repellant, and is recommended.

FUNGICIDES AND INSECTICIDES.

FORMULÆ.

I. Bordeaux Mixture.

Copper sulphate (blue stone)	4 pounds.
Fresh stone lime	4 pounds.
Water	40 gallons.

(1) Make a stock solution of bluestone by dissolving 40 pounds in warm water in a barrel and add water to make up to 40 gallons. Every gallon of this solution in first barrel contains one pound of bluestone.

(2) Into a second barrel put 40 pounds of fresh stone lime, and add with stirring small quantities of water to slake it. When fully slaked make up to 40 gallons by adding water. Every gallon of milk of lime in this second barrel contains one pound of lime.

To prepare the Bordeaux, empty four gallons of bluestone solution into the spray tank or barrel, which already should have 25 or 30 gallons of water in it; stir the milk of lime thoroughly and empty four gallons of it through the strainer into the spray barrel with constant stirring; then add water to make up to 40 gallons.

Any one of several arsenical compounds may be used along with the Bordeaux to form a combination insecticide and fungicide. The following are among the best:

(a) *Paris Green*. Add four to six ounces to 40 gallons of Bordeaux.

(b) *Arsenite of Soda*. Boil together for 15 minutes one pound white arsenic, four pounds sal soda, and two gallons water, until a clear solution is obtained. Add one to one and one-half quarts to 40 gallons of Bordeaux.

(c) *Arsenite of Lime*. Boil together for 45 minutes one pound arsenic, two pounds fresh lime, and one gallon of water. Add one quart of this solution to 40 gallons of Bordeaux.

(d) *Arsenate of Lead*. Put four ounces of arsenate of soda in two quarts of water in a wooden pail and eleven ounces acetate of lead in two quarts of water in another pail. When dissolved mix together and add to 40 gallons of Bordeaux.

(3) *Never mix the concentrated stock solutions together*. If the milk of lime and bluestone are mixed in the concentrated form, just as they are taken from the stock solution, a precipitate of a flaky nature will soon settle out, and either fall to the bottom or clog the nozzle.

(4) *Test the Bordeaux to find out whether sufficient milk of lime has been added*. This is most easily done by means of the ferrocyanide test. A saturated solution of this substance can be purchased at any druggists for a few cents. In testing, place some of the Bordeaux, which has been thoroughly stirred, into a saucer, and add a few drops of the ferrocyanide. If sufficient lime has been used, no discoloration will appear, but if insufficient, a deep dark brown color will be produced.

(5) *Always strain the milk of lime* to prevent gritty particles from clogging the nozzles.

(6) *Use a fine nozzle*; do not soak or drench the plants.

(7) *The stock solutions will keep*, but the Bordeaux mixture becomes useless after standing for two or three days.

II. Resin-Bordeaux Mixture.

Pulverized resin	5 pounds.
Concentrated lye	1 pound.
Fish oil	1 pint.
Water	5 gallons.

Place the oil, resin and one gallon hot water in an iron kettle and heat till resin softens, add the lye and stir thoroughly; then add

four gallons hot water and boil till a little will mix with cold water and give a clear, amber-colored liquid. Add water to make up five gallons. Keep this as stock solution. For resin-Bordeaux, add ten gallons water to two gallons of stock solution, then mix this with 40 gallons Bordeaux.

This mixture is very adhesive to smooth leaves; has been used successfully against asparagus rust.

III. Ammoniacal-Copper Carbonate Solution.

Copper carbonate	5 ounces.
Strong ammonia, sufficient to dissolve the copper carbonate, usually about	3 pints.
Water	40 gallons.

Mix the copper carbonate into a paste with a little water, add the ammonia, and when the copper carbonate is completely dissolved pour the deep blue solution into the water.

Recommended for late spraying against fungi to prevent disfiguration of fruit or leaves.

IV. Potassium Sulphide (Liver of Sulphur.)

(Used to control Mildews.)

Dissolve four ounces in eight gallons of water.

V. Flowers of Sulphur.

(Used in California against Asparagus rust.)

VI. Formalin (40 per cent. Formaldehyde.)

Put one-half pint into 15 gallons of water.

Used for prevention of bean anthracnose, potato scab.

VII. Cook's Carbolic Soap Wash.

Hard soap, one pound, or soft soap	1 quart.
Crude carbolic acid	1 pint.
Water (boiling)	1 gallon.

Dissolve the soap in the boiling water; while still hot add the carbolic acid; emulsify thoroughly. This is the stock solution. For use, dilute with 30 to 50 times its bulk of water. Very effective against root-maggots of cabbage, radish and onion.

VIII. Paris Green Mixture. (Liquid.) (For Leaf-eating Insects.)

Paris green	1 pound.
Water	150 gallons.
Lime, freshly slacked	2 pounds.

Or,

Paris Green Mixture. (Dry.)

Paris green	1 pound.
Flour or dust	100 pounds.

IX. Poison Bait. (For Cutworms, Wireworms and Grasshoppers in gardens and cornfields.)

Wheat bran	50 pounds.
Molasses (any kind)	2 quarts.
Paris green(good grade)	1 pound.
Water	(Enough to make a thick mash.)

Handfuls of the bait are scattered about the garden at the base of the plants and among the corn rows in the evening.

Poisoned clover, slices of potato, etc., may be used effectively.

X. Hellebore.

White hellebore (fresh)	1 ounce.
Water	2 gallons.

XI. Pyrethrum, or Insect Powder.

Pyrethrum powder (fresh)	1 ounce.
Water	3 gallons.

Or,

Pyrethrum powder	1 ounce.
Flour (cheap)	5 ounces.

Mix thoroughly, allow to stand over night in a closed box, then dust on plants through cheese-cloth.

XII. Kerosene Emulsion (for Bark-lice and Plant lice.)

Hard soap, half-pound, or soft soap.....	1 quart.
Boiling water (soft)	1 gallon.
Coal oil	2 gallons.

After dissolving the soap in the water, add the coal oil and stir well for five to ten minutes. When properly mixed, it will adhere to glass without oiliness. A syringe or pump will aid much in this work. In using, dilute with from nine to fifteen parts of water.

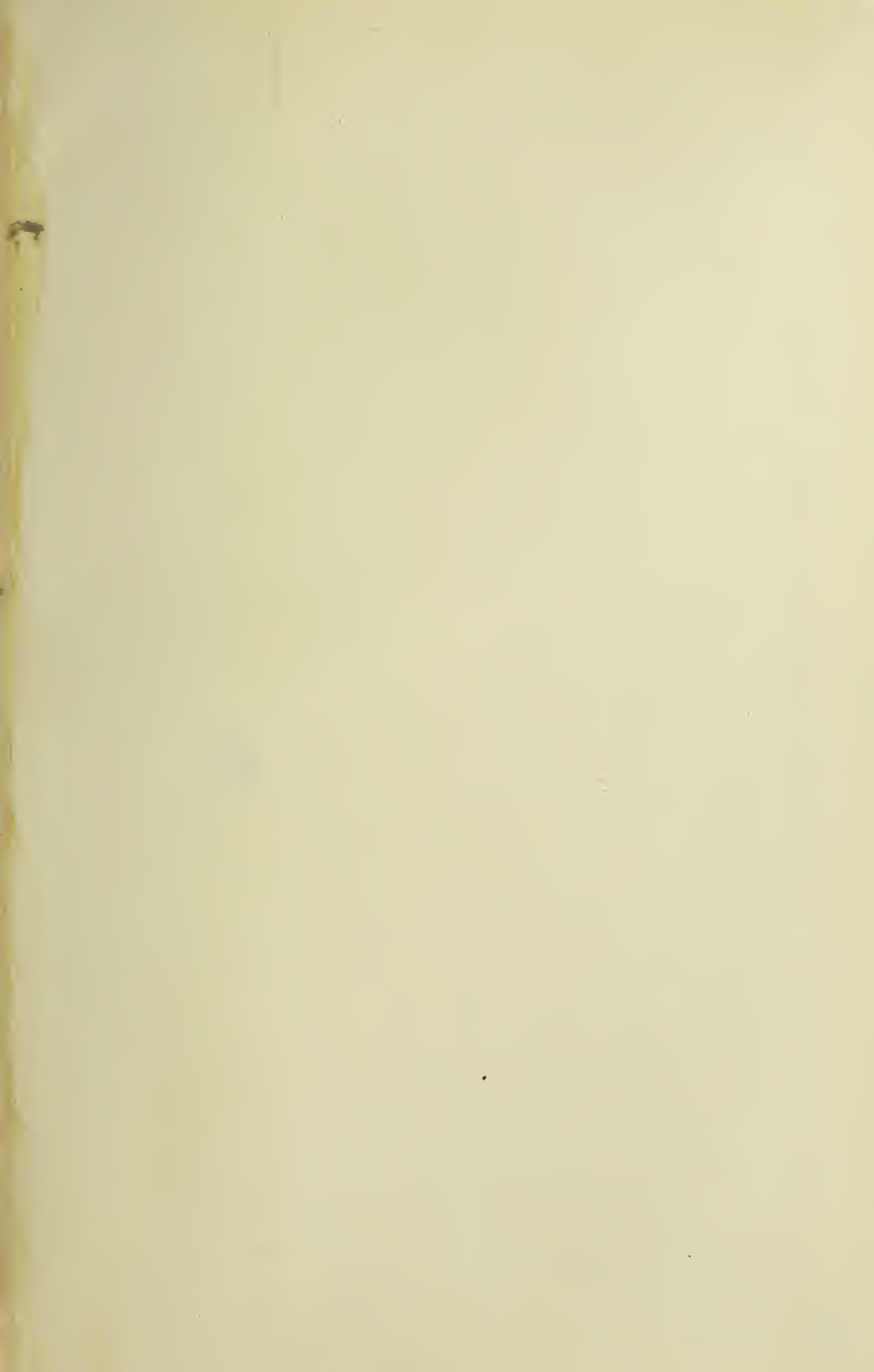
XIII. Tobacco Decoction.

Refuse tobacco	2 pounds.
Water	5 gallons.

Boil the mixture for 30 minutes or more, until a dark brown tea-colored solution is obtained. Keep it covered until cool. It may then be used undiluted for spraying infested plants. The addition of one pound of whale-oil soap to each 50 gallons increases the effectiveness.

XIV. Whale Oil Soap.

For plant lice, one pound in seven gallons hot water.







UNIVERSITY OF ILLINOIS-URBANA



3 0112 112411274